HAER No. NV-33

Nevada Test Site, Test Cell A Facility
Area 25, Jackass Flats
Road F
Mercury Vicinity
Nye County
Nevada

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of the Interior
San Francisco, California 94107

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HISTORIC AMERICAN ENGINEERING RECORD
NEVADA TEST SITE, TEST CELL A FACILITY
HAER NO. NV-33

Location: Road F, Jackass Flats, Area 25, Nevada Test Site, Mercury Vicinity, Nye County, Nevada

USGS Jackass Flats 7.5'
UTM Coordinates Zone 11 E 566,000 N 4,075,930
(Building No. 3113/3113A)

Date of Construction: 1958

Engineer/Builder: Petroleum Combustion and Engineering Company, Los Angeles

Present Owner: Department of Energy, Nevada Operations Office
P.O. Box 98518, Las Vegas, NV 89193-8518

Present Occupant: Not occupied

Present Use: Vacant; no public access; to be demolished

Significance: The Test Cell A facility was a critical component of the nuclear reactor propulsion research conducted during the Rover project for the United States space program. Constructed to test nuclear reactors, Building 3113/3113A, the main structure of the facility, exemplifies a style reflective of nuclear power research for rocket propulsion with the accompanying structural and technological elements. Although the project did not result in an actual flight, it revealed that such missions were technically feasible and the knowledge gained is still part of the space program today. Termination of the project was in 1973.

Report Prepared by: Colleen M. Beck and Harold Drollinger
Desert Research Institute
755 East Flamingo
Las Vegas, NV 89119

Nancy Goldenberg
Carey & Company, Inc., Architects
Old Engine Co., No. 2
460 Bush Street
San Francisco, CA 94108

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I. CONTEXTUAL INFORMATION

The Test Cell A facility was an integral component of the Nuclear Rocket Development Station (NRDS) operations in Area 25 (originally Area 400) of the Nevada Test Site (NTS) (Figures 1-3). The NTS was originally administered by the Atomic Energy Commission (AEC) and later by the Department of Energy, Nevada Operations Office (DOE/NV). Other major facilities of the NRDS were a second and larger test cell (Test Cell C), a Reactor Maintenance Assembly and Disassembly (R-MAD) facility, an Engine Maintenance Assembly and Disassembly (E-MAD) facility, an Engine Test Stand (ETS-1), the Reactor Control Point complex, and the Support Area complex. The NRDS is reached from the town of Mercury by either the Jackass Flats Road directly or the Cane Spring Road via the Mercury Highway. Both routes are paved and eventually cross at an intersection at the southern edge of the NRDS complex where the 500 Gate checkpoint is located. The Test Cell A facility is located north from the intersection along Road C, passing through the Reactor Control Point complex and past the turnoff to Road J and Test Cell C, and then further northeast on Road F. The facility is at a curve on the north side of the road.

The setting of the Test Cell A facility is toward the northern edge of Jackass Flats, an open valley at the northern extent of the Mohave Desert. Elevation of the facility is 3,830 ft (1,167 m). Yucca Mountain is to the west and southwest and Skull Mountain and Little Skull Mountain to the southeast and south. Skull Mountain reaches an elevation of almost 6,000 ft (1,829 m), while Yucca Mountain approaches 5,000 ft (1,524 m). The Calico Hills are directly north and Mid Valley and Lookout Peak are to the northeast. Fortymile Wash is to the west. It is the largest drainage in the area and meanders southward along the east base of Yucca Mountain and west side of Jackass Flats, eventually joining with the Amargosa River. Topopah Wash, originating in the Calico Hills, runs in a south-southwesterly direction across the central part of Jackass Flats, draining its eastern half, and skirting Little Skull Mountain on its western side until it too joins the Amargosa River. Surrounding vegetation is creosote bush (*Larrea tridentata*), bursage (*Ambrosia dumosa*), blackbrush (*Coleogyne ramosissima*), Mormon tea (*Ephedra nevadensis*), thornberry (*Lycium* sp.), and in lesser amounts, other shrubs, grasses, and cacti. In the area are kit fox, desert tortoise, western shovelnose snake, the sidewinder snake, speckled rattlesnake, gopher snake, coyote, bobcat, raven, red-tailed hawk, black-tailed jackrabbit, desert and Nuttall's cottontail, long-tailed pocket mouse, kangaroo rat, desert woodrat, white-tailed antelope squirrel, black-throated sparrow, horned lark, Say's phoebe, western kingbird, loggerhead shrike, chuckwalla, side-blotched lizard, and desert horned lizard. Other animals in the region include mountain lion, chukar, Gambel's quail, morning dove, golden eagle, and occasionally, bighorn sheep and antelope. The nearest natural water source is Topopah Springs; however, several drilled NTS wells were the source of water supply for the facility when the NRDS was in operation (Space Nuclear Propulsion Office 1969:145). The first of these, J-11 and J-12, were drilled in 1957 and a third one, J-13, in 1962 when the casing failed on the first well. All were over one thousand feet deep. The wells served two interconnected water delivery systems, one for the northern area of the NRDS and the other for the southern, with each system serving as a backup to the other, particularly for emergencies, such as fire.

The mission of the NRDS, managed by the Los Alamos Scientific Laboratory (now the Los Alamos National Laboratory), University of California, was to develop and test nuclear rocket engines and reactors during the Rover project for the space program of the United States (AEC 1961:69; House 1963). The objective in the development of this type of nuclear engine was to enable the United States to undertake long and complicated journeys not possible at the time with existing methods (House 1963; Schreiber 1961:25, 29). The program at the NTS began in 1957 and ended in 1973 (AEC 1974:23; Friesen 1995:1; Miller 1984:5). The Test Cell A facility has been determined eligible to the National Register of Historic Places through consultation between DOE/NV and the Nevada State Historic Preservation Office and is currently slated to be demolished under the Environmental Management Deactivation and Decommissioning Program (Carlson 1999).

In 1958 the test cell and tank farm were built by Petroleum Combustion and Engineering Company of Los Angeles. The contractor for the water storage tank was the Pittsburgh-Des Moines Steel Company of El Monte, California with A.D. Schader Company of San Francisco responsible for the railroad facilities (AEC 1958a:4). The facility (Figures 4-10, Photograph NV-33-1) is surrounded by a chain link fence and contains 18.4 ac (7.4 ha). Entrance to the facility was controlled through three main gates with multiple ancillary gates built into the fencing system. Two double gates are at the southwest corner and are positioned 80 ft (24 m) apart. Both provide access to the two primary roads within the facility. One leads northwest to a trailer parking area and the other crosses the facility to the east and terminates at the test cell. The third double gate is at the south end of the complex on the east side, south of the test cell. This gate provided direct access to the other trailer parking area. Double gates also were used to control access on the railroad tracks. The ancillary gates around the complex are single gates, used by foot traffic for access. Within are 19 buildings and structures.

The Test Cell A facility initially consisted of the test cell (Building 3113), the tunnel and tunnel headhouse (Building 3114), the helium compressor station (Building 3115), the pump station (Building 3116), the pressure reducing station (Building 3117), the process piping system (Building 3118) and the shed drive house (Building 3133). Additions were made between 1960 and 1964 with construction of the LH_2 fill station (Building 3134) in 1960, and the test cell addition (3113A), the north camera tower (Building 3138) and the south camera tower (Building 3139) in 1961. The tank farm building (Building 3115a) and the equipment test laboratory (Building 3124) were built in 1962. The camera bunkers (Buildings 3135, 3136 and 3137), the air conditioning building (Building 3170) and the transformer house

(Building 3137) were completed in 1964. The facility was last used for testing purposes in 1966.

Toward the west end of the facility is Building 3124, formerly the equipment test laboratory. Rehabilitated in the early 1990s, this building was re-used in a plutonium soils separation pilot test project of short duration. Southeast of this location (Photograph NV-33-2) is the compressor station (Building 3115), the tank farm building (Building 3115A), the pumping station (Building 3116), the distribution building (Building 3109), and the tunnel entrance and tunnel (Building 3114) (Photograph NV-33-B-1). Central to the facility is the test cell (Building 3113/3113A). West of the test cell was a horizontal dewar (no longer present). Adjoining to the south is an open, steel monument frame structure clad with corrugated metal and a spherical dewar with a 120,000 gallon capacity for liquid hydrogen (Photograph NV-33-C-1). To the east of this dewar and north of the LH_2 fill station (Building 3134) were two horizontal dewars that were removed for use in other facilities. East of the test cell is a concrete pad with railroad tracks on which the tests were staged. On these tracks is the moveable shed (Building 3130) (Photograph NV-33-D-1), now sitting towards the east end of the track near the shed drive house (Building 3133). Northwest of the test cell is a sandbagged, bermed, hemispherical bunker (Photographs NV-33-E-1 and NV-33-E-2), and a 100,000 gallon water tank elevated on a tower (see Photograph NV-33-1). To the west of the bunker is the tank farm (Photograph NV-33-3), an area that contained banks of horizontal fuel tanks now removed. Also present is a vaporizer shed near Building 3115, a 50,000 gallon elevated ground reservoir near Building 3116, substation NRDS #9 near Building 3109, and other sheds (E-28576 and E-29380) on the periphery of the facility. Trailer parking areas were on the southwest side near Buildings 3115 and 3115A and south of Building 3134. The facility was constructed with the piping and systems necessary for the storage and transfer of fluids, such as liquified and gaseous hydrogen, nitrogen and helium, liquid oxygen and demineralized cooling water with complex piping systems throughout (Space Nuclear Propulsion Office 1969: 64-65, 99).

Originally, train tracks from the R-MAD terminated at the east wall of the test cell adjacent to Building 3113/3113A. Concurrent with the later construction of Test Cell C, the railroad tracks were extended from Test Cell A to that location. This extension crosses the Test Cell A facility on the northeast side with a westward spur into the pad area east of the test cell. The tracks were realigned across the concrete pad at Test Cell A in order to attach to the addition to the test cell (Building 3113A).

Three bermed wooden camera bunkers are outside the fence on a 1,000 foot arc from northeast to south of the facility (Space Nuclear Propulsion Office 1969:16). Also, two camera towers have been removed. Still standing is a 50 foot high photo tower 2,000 feet (609.6 m) to the south.

II. ARCHITECTURAL AND ENGINEERING INFORMATION

Building 3113/3113A is in the central portion of the facility. It is almost U-shaped in plan and primarily one story, with a partial second story or penthouse consisting of two separate rooms, each accessed from the roof. The building can be divided into three sections (see Figure 10), representing three periods of construction: a central, original portion (Building 3113); an addition (Building 3113A) to the south, constructed of materials similar to the original; and a projecting unnumbered wing of distinctly different construction. The original building was 46 ft (14 m) in length, 41 ft (12.5 m) in width with a height of 19 ft 8 in (6 m) for the ground floor with a floor area of about 1,886 sq ft (175.2 sq m). The original construction also included a single-room penthouse. The addition to the south in 1960 is 57 ft 1 in (17.4 m) in length, 33 ft 4 in (10.1 m) in width with a height of 19 ft 8 in (6 m) and a floor area of approximately 1,904 sq ft (176.7 sq m). A second room was added to the second floor penthouse after completion of this addition. The third section of the test cell was the last construction and consists of a wing of rooms extending west from the northwest corner of the original building. It is 50 ft (15.2 m) long and 12 ft (3.6 m) wide, and contains 600 sq ft (55.7 sq m). The north, south and west walls of the original building, the penthouse and the south addition are 1 ft 8 in (.5 m) thick, consisting of reinforced concrete. The east wall is made of reinforced concrete 4 ft 7 in (1.4 m) thick. This dense wall was required to shield the interior of the building from the reactor tests conducted outside against the east wall. In contrast, the west wing is built of concrete masonry units (CMU). Another safety measure was a tunnel accessed by a descending stairway in the southwest corner of the original building. The tunnel extends for 300 ft (91.4 m) west-southwest to Building 3114, the tunnel entrance.

Exterior

The exterior of Building 3113/3113A (Figure 11) is a complex mass of concrete, CMU and corrugated metal. Metal staircases, railings and equipment mount on or near the building over most of the exterior, at times obscuring the building from view. The roof of the building behind the east facade is covered with piping and metal rails (Photographs NV-33-A-1 and NV-33-A-2). The east elevation (Photographs NV-33-1 and NV-33-A-3), standing at the edge of a paved concrete expanse, presents a planar concrete wall. The wall consists of a high, irregularly-shaped portion to the north (3113) and a lower rectangle to the south (3113A). Centered low on the wall is a rectangular opening, approximately 10 ft (3 m) wide by 5 ft (1.5 m) high. Ferrous metal groove unistrut strips imbed into this central portion. Reactors were mounted against this face for tests. A two-foot diameter steel pipe dominates the north elevation. This pipe projects at least 50 feet northward terminating in a vertical piece of equipment, called the flare (Figures 12-13, Photographs NV-33-A-4 and NV-33-A-5). Otherwise, this elevation consists of a concrete rectangle with a smaller, setback penthouse representing the initial period of construction, with a lower CMU rectangle extending westward. A steel staircase ascends from the ground to the first level roof, then up to the penthouse roof. Steel pipe railings are visible on top of both levels.

The west elevation (Photographs NV-33-A-6 and NV-33-A-7) is a two story complex mass. A one-story CMU addition, lower than the remainder of the structure, projects far into the foreground. The original portion of the building consists of a high ground floor. The south mass (3113A) projects further forward than the original, as does the later wing to the north, creating a U-shape with a center recess. The recess contains a non-original, projecting entry vestibule, and an abundance of equipment mounted on and projecting through the building, especially the southern addition. A metal pipe railing tops the original portion of the building. The penthouse level is recessed towards the east.

The south elevation exposed today is that of the addition (3113A), a high one-story concrete mass. A higher concrete shielding wall forms the eastern boundary of the facade, projecting southward approximately 50 feet farther than the main 3113A building mass. The penthouse rooms form the second story, along the eastern edge of the roof: the corrugated metal room in the foreground, the lower concrete one in the background. A tangle of equipment, pipes and tanks, occupy the concrete pad to the south of the building, obscuring most of the south elevation from view (Photograph NV-33-4).

Interior

Interior surfaces of the building are primarily concrete. Surfaces post-dating the original period of construction may be CMU or corrugated metal. There are seven rooms on the ground floor of building 3113/3113A: a rectangular instrument room central to the building; a radiation effects room connected to the instrument room; a large rectangular flow control room; an equipment room; an office/storage room; and two restrooms. On the second level penthouse are two rooms containing additional equipment. Except for the radiation effects room which is entered through the Instrument room, all rooms have separate, exterior entrances. Room numbers used in this description were added for reference and are shown on the attached reference floor plan (Figure 14).

Room 1 (3113) is the rectangular-shaped instrument room and is entered through a non-original anteroom at its western end (Figures 15-19, Photographs NV-33-A-10 and NV-33-A-11). The floor, ceiling and all walls are concrete. Double metal doors enter both the anteroom and Room 1 itself. A closed-up rectangular opening used to connect to the test device from the interior, penetrates the back, east wall. Horizontal unistrut imbeds in the walls serve as equipment mounting hardware. Ladder-like cable trays hang below the ceiling. A staircase leading to the tunnel occupies the room's southwest corner (Photograph NV-33-A-12). Banks of control-type equipment, including dials, switches, gauges and video monitors, fill the room. Lighting includes both metal incandescent pendant and strip fluorescent fixtures.

Room 2 (3113), the radiation effects room (Photograph NV-33-A-13), is a long, rectangular space located north of the Instrument room and is accessed through two door-less openings near the east and west end of the instrument room. All interior surfaces are concrete, but unlike the Instrument Room, the walls do not feature horizontal grooves. The radiation effects room contains electrical equipment. Construction drawings dated 1957 show that concrete walls originally divided this space into three rooms but later drawings in 1965 show these walls removed. The room was lit by strip fluorescent fixtures.

Room 3 (3113A) is entered at the west end of the north side through a double metal door. Identified as the flow control room, this large rectangular room is entered through a double metal door at the west end (Figures 14 and 19). The flow control room is filled with mechanical and turbine equipment, some located inside an interior metal framework (Photograph NV-33-A-14). Featuring concrete walls, floor and ceiling, the room was lit by incandescent pedants.

The northwest wing (Figures 10 and 14, Photographs NV-33-A-5 and NV-33-A-7), projecting westward from the west end of the radiation effects room, consists of four rooms (Rooms 4-7) in a linear pattern. They are individually accessed from the exterior and none interconnect. No plan maps or architectural drawings were found for this wing.

Room 4, a small equipment room, is square with a concrete floor, CMU exterior walls, and concrete dividing walls (Photograph NV-33-A-15). The concrete ceiling features uni-strut imbeds. Double doors at the south wall access the space from the exterior. Raised concrete pads hold mechanical equipment including generators. Enameled metal industrial pendants light the room.

Room 5 is similar to Room 4 but does not contain equipment. The presence of shelving points to the likelihood that this room was used for an office or storage (Photograph NV-33-A-16). The room has an opening on the north wall that may have once held an air conditioning unit. Double metal doors access the space on the south wall. Built-in shelving occurs on the north, east and west walls. Ceiling mounted strip fluorescent light the space. A large 18 in by 18 in sheet metal duct mounts at the ceiling along the north wall.

Rooms 6 and 7 are men's and women's restrooms with concrete and CMU surfaces similar to the other rooms in this wing. The rooms feature wall-hung sinks, tank toilets, urinals in the men's room, and metal partitions (Photographs NV-33-A-17 and NV-33-A-18).

On the second level are two adjacent rooms (P-1 and P-2), known as the penthouses (Figures 16 and 20, Photograph NV-33-A-8). P-1 sits over the original portion of the building. Walls, floor and ceiling are concrete, with a massive metal door at the west elevation (Photograph NV-33-A-19). A concrete curb at the north wall encloses an opening in the floor, with ladder access to the first floor instrument room. All walls feature an abundance of wall-mounted equipment. P-2 is accessed through a single metal door on the west wall (Photographs NV-33-A-9 and NV-33-A-20). This room has a concrete floor and concrete north and east walls. Corrugated metal forms the south and west walls and the ceiling. Vertical unistrut imbeds striate the east wall. The northern end of the room is elevated one step, with many pipes in the northeast corner. Both rooms were lit with pendant incandescent light fixtures.

III. HISTORICAL INFORMATION

The concept of nuclear-propelled rockets was initially discussed in 1944 by personnel at both LASL and the University of Chicago Metallurgical Laboratory (Bussard 1962:169; Bussard and DeLauer 1965:1). Following these discussions, the first serious study dealing with the concept of nuclear rockets, aircraft, and ramjets was produced in 1946 as a secret document by personnel at the Applied Physics Laboratory, John Hopkins University (Bussard 1962:169; Bussard and DeLauer (1965:2). This document summarized the contemporary information about nuclear propulsion and the principles and problems for developing such systems. What was made evident in the document was that little or nothing was known about specific properties of materials in order to build the systems. A second secret document was prepared in 1947 by the Aerophysics Laboratory, North American Aviation Corporation, focusing on nuclear ramjets and rockets of different sizes for military purposes (Bussard 1962:170; Bussard and DeLauer 1965:2).

In 1946, the U.S. Air Force established the Nuclear Energy for Propulsion of Aircraft (NEPA) project at the Oak Ridge National Laboratory, Tennessee for exploring the possibility of low-altitude nuclear aircraft (Bussard and DeLauer 1965:2; Larson 1950:2). Work on this project continued intermittently until 1949 (Bussard 1962:170). The Lexington Project, an ad hoc study group convening in 1948 at the Massachusetts Institute of Technology at the behest of the AEC, determined the least difficult system to develop was the low-altitude nuclear aircraft, followed by the nuclear ramjet for powering missiles, with the nuclear rocket being the most difficult. The NEPA project evolved into a new and expanded Aircraft Nuclear Propulsion (ANP) program in 1951 when the U.S. Air Force joined with the AEC to develop the systems, focusing primarily on manned military aircraft (AEC 1956). In 1955 the U.S. Navy also became interested and requested a feasibility study for a nuclear-powered seaplane (AEC 1956). The ANP program ended in 1961, however, with few results (Bussard and DeLauer 1965:4). In contrast to the earlier beliefs, it was found that a nuclear-propelled low-altitude aircraft was the most difficult of the three systems to develop, due mostly to size constraints and safety considerations. Furthermore, it was determined little advantage was to be gained in developing ballistic missiles powered by nuclear engines. Chemically-propelled missiles had already been developed, and effort and money could be spent elsewhere (Baker 1996:62; General Advisory Committee 1960:28).

In the 1950s, an article by Bussard (1953), who was working at the Oak Ridge National Laboratory at the time, on the potentialities of a wide range of missions for nuclear rockets, sufficiently influenced the U.S. Air Force to direct, through the AEC, the LASL and UCRL to study the feasibility of linking nuclear power with rockets (AEC 1962:71; Baker 1996:48-49; Bussard 1962:170; Bussard and DeLauer 1965:3; General Advisory Committee 1956:18-24; House 1963). The great appeal of nuclear propulsion, as opposed to chemical propulsion, was its smaller size and greater velocity to enable bigger payloads. Consequently, it was considered more efficient and preferable than chemical systems, particularly in the long and complex journeys for exploring the solar system (see Angelo and Buden 1985:ix; Schreiber 1961:25, 29). In 1955, the Condor committee of the U.S. Air Force Scientific Advisory Board recommended that work was to begin on a nuclear-propelled rocket (Baker 1996:55; House 1963). In 1957, a Rover reactor approach using uranium-loaded graphite fuel was selected as the method to be developed based on the studies by LASL and UCRL (AEC 1962:71). Construction and testing of reactors for rockets was assigned to LASL within the Rover project, while UCRL was given a similar task for ramjets, thereafter referred to as the Pluto project (AEC 1958a, 1958b; Schreiber 1958:70).

The NTS, with a record of nuclear weapons testing, including atmospheric or above ground tests, was chosen as the place to conduct the nuclear reactor tests because of the possibility of an excursion within the reactor, and also, the tests released a radioactive exhaust plume into the atmosphere that was acceptable for the NTS at the time (AEC 1958a; see Bernhardt et al. 1974; House 1963; see Friesen 1995). Initial development of the NRDS in 1956 was a joint AEC and U.S. Air Force effort that eventually evolved into an AEC and National Aeronautics and Space Administration (NASA) project (AEC 1957:10, 1958a, 1961:71, 1964:109; Baker 1996:57; Beck et al. 1996:26; House 1963; Miller 1984:1). In 1961, the NRDS area, about 318,000 acres, was officially withdrawn to the AEC from the Nellis Air Force Range under Public Land Order 2568 (Space Nuclear Propulsion Office 1969:75). The mission of the AEC was to develop nuclear reactors and reactor technology, while NASA, who had taken over the role from the U.S. Air Force, had the responsibility to develop nuclear engines and engine technology and for the integration of the reactors into engines (AEC 1963:168). Administration of the program was by a newly created Space Nuclear Propulsion Office located in Georgetown, Maryland, headquarters of the AEC, with operating extensions in Albuquerque, Cleveland, and Las Vegas.

The primary mission of the NRDS at the NTS was to support the Rover project in developing nuclear rocket reactors and engines for the space program (AEC 1961:69; House 1963; Miller 1984:1). Initially, three stages were outlined for the program. The first stage was to develop test reactors in order to investigate and solve various problems in achieving a high-power density, to develop reactor materials capable of withstanding high temperatures, and to generate new concepts for converting nuclear energy into useful propulsion forms (AEC 1960:77). The second stage was to develop and test a nuclear engine for actual flight and the third stage, performed by NASA, was to incorporate the engine into a Saturn V launch vehicle for flight testing (AEC 1964:109; Schreiber 1961:33).

The first nuclear rocket test reactor at the NRDS, designated Kiwi-A, was conducted in 1959 (AEC 1961:69; Bussard and DeLauer 1965:3; Schreiber 1961:29). More test series followed, including NRX, Phoebus, Pewee, XE, and Nuclear Furnace (Angelo and Buden 1985:179-183; DOE/NV 1985:2-2, Table 6.2.1; Friesen 1995). Following the initial outline of the Rover project, the objective of the Kiwi test series was to develop the reactor technology and design (Schreiber 1958:70). The ground-based Kiwi reactor, appropriately named after a flightless New Zealand bird, would become the basic design for the NERVA (Nuclear Engine for Rocket Vehicle Application) engine to be flight-tested in the RIFT (Reactor in Flight Test) vehicle (AEC 1963:168, 1965:111). The RIFT vehicle would then be developed for an upper stage on an advanced Saturn rocket, capable of putting large payloads on the moon for lunar-based missions. The module would also be used for manned missions to Mars or Venus (AEC 1967:181).

In late 1963, the Rover program was revised, emphasizing ground-based research and engineering. That is, the Kiwi project was unchanged, worked continued on the NERVA engine technology, but the planned RIFT stage was cancelled (AEC 1964:110). Early in 1972, the NERVA project was cancelled (AEC 1973:25). Eventually, further budget restrictions in 1973 led to a termination of all space-oriented nuclear propulsion development efforts and the entire NRDS program was phased out at the end of the fiscal year. Management and responsibility for the NRDS area was assumed by the Nevada Operations Office (AEC 1974:23; Miller 1984:5). Despite this abrupt ending, the significant technological advances made during the Rover program proved the feasibility of nuclear-propelled vehicles and constitute the primary building blocks for future space explorations in the twenty-first century (e.g., Porta 1995). Overall, the program can be considered a successful pioneering achievement in the space program of the United States.

Test Cell A

Test Cell A was the first nuclear rocket reactor testing facility in the United States. It is here that ideas regarding the viability of rocket reactor construction literally were put to the test and the concept of nuclear rocket reactors became a reality through a process of repeated tests and design modifications. The innovativeness of the Rover program required addressing the functionality of the facilities as well as the reactors, resulting in continual modifications to the Test Cell A facility from its completion in 1958 through 1964. The Test Cell C design benefitted from the knowledge gained during the early years of testing at Cell A and, although the facilities operated concurrently between 1961 and 1966, the ever increasing size and fuel needs of the reactor and engine system tests contributed to the closure of the Test Cell A facility late in 1966. After almost eight years of operation, at least ninety reactor and system tests had been conducted there for the Rover program (Table 1).

The reactors were assembled at the R-MAD (Figure 21) and mounted on a flatbed railroad car for transport to Test Cell A (Figure 22). The railroad car also served as the testing platform and was placed against the outside of the east wall of Building 3113/3113A on a large concrete pad. Then the reactor, positioned to exhaust upward, was connected to interior instrumentation equipment and fuel piping (AEC 1958a:4). After all equipment checks were completed, the facility was vacated for the duration of the test. As a safety precaution, all buildings through which the main hydrogen line passed were filled with nitrogen to prevent a fire or explosion in the event of a hydrogen leak.

The tests were controlled remotely from the Remote Control Point, approximately 2 mi (3.2 km) southwest and all instrumentation data were relayed to recording instruments there (AEC 1958a:4). Documentary photographs and films were recorded in the camera bunkers and photo towers. Following completion of a test and a determination that radiation and gas levels were safe, personnel returned to the facility. If a reactor was scheduled for more tests in the immediate future or awaiting transport to the R-MAD, the moveable shed was utilized as a garage to protect the equipment. While transport of the reactor to Test Cell A was accomplished with a manned railroad engine, the reactor usually was returned to the R-MAD for disassembly by a remote controlled, unmanned engine to reduce potential radiation exposure to personnel.

Reactors tested at Test Cell A were the Kiwi A, Kiwi B, Cold Flow, NRX A4 EST and the NRX A5 (Friesen 1995:5-6; Taub 1975:45-47). Kiwi A tests were conducted from November 18, 1958 to October 19, 1960 (Figure 23). The Kiwi Program objectives were "first to demonstrate the proof of principle, then to establish the basic reactor technology and develop sound design concepts" (Koenig 1986:2). Between November of 1958 and July of 1959, all tests were Kiwi associated systems tests with the first full reactor test, Kiwi-A, on July 1, 1959. This test was successful with the reactor operating for five minutes, providing important design and materials information (Koenig 1986:4). Vibrations caused some internal damage to the fuel elements (Koenig 1986:4; Taub 1975:4,45). More than a year later, on July 8, 1960, Kiwi A Prime was run for almost six minutes to test improved fuel elements with the same result. This was followed by the Kiwi A 3 reactor test on October 10, 1960, and as with the previous Kiwi tests, core structural damage occurred (Koenig 1986:4; Taub 1975:5-6,45). The Kiwi A 3 reactor test was the last in the Kiwi A series of proof-of-principle tests conducted by LASL. These tests demonstrated the feasibility of the reactors by showing that they could be controlled and could heat hydrogen gas to high temperatures (Koenig 1986:4).

Reactor designs were modified and the Kiwi B reactor test series began with Kiwi B1A on December 7, 1961, the last reactor test run with gaseous hydrogen coolant. The test was terminated after less than minute due to a hydrogen leak in the nozzle (Koenig 1986:5). This test followed the addition of the flow control room to the test cell. Two Kiwi B series tests were conducted in 1962 after repeated cold flow system tests, i.e., systems tests producing no power. The Kiwi B1B reactor test on September 1, 1962 was the first to operate with a liquid hydrogen system. However, the test was terminated after pieces of fuel elements were ejected from the reactor. On November 28, 1962, the Kiwi B4A, the first reactor designed as a prototype flight reactor, was tested with the run terminated when core material was ejected in the exhaust (Koenig 1986:5; Taub 1975:7,46).

The LASL scientists continued to grapple with the structural problems and cold flow tests were carried out to determine the cause and find solutions for the structural damage occurring during the reactor tests (Koenig 1986:5). The reactors in the cold flow tests contained no fissionable materials. Systems tests were conducted at Test Cells A and C in 1963. During these experiments, it was determined that the structural core damage was caused by flow-induced vibrations (Koenig 1986:6; Taub 1975:46). Structural design changes in the reactors eliminated the vibrations (Taub 1975) and were followed by successful Kiwi B series full run reactor tests at Test Cell C in 1964. Following the cold flow tests, no tests were conducted at Test Cell A from early October 1963 until early December 1965 (Table 1). During this two year hiatus, buildings and structures were added to the Test Cell A facility.

In the meantime, Phase Two of the Rover program was initiated. NERVA, an Aerojet General/Westinghouse effort, was designed to provide the technology for a complete nuclear rocket engine capable of flight based on the Kiwi reactor design and technology (AEC 1966:142, 1968:169). In 1966 Test Cell A was used for initial testing of components of the Nuclear Reactor Experiment/Engine Test (NRX/EST), the NRX A4 EST and the NRX A5 (Taub 1975:47). The NRX A4 EST was the first test consisting of all the engine components and was the first operation of a NERVA breadboard power plan with engine components connected in a flight-functional relationship (Koenig 1986:17). It was also the first to self-start, demonstrating that a nuclear-powered rocket could start and operate on its own power (Friesen 1995:6; Taub 1975:47). Other initial NERVA tests were conducted at Test Cell C. The XE Prime was the first engine to be tested, at the ETS-1, in the correct flight configuration, that is, all the parts were put together in the proper sequence. In 1967, the NRX A6 operated at full power for one hour.

With larger fuel capabilities and facilities at Test Cell C and the completion of the ETS-1, Test Cell A was deactivated at the end of 1966. Having made a major contribution to the development of nuclear reactor propulsion systems for the United States Space Program, the facility remains a testament to the innovativeness and scientific progress made during its tenure. In January of 1973, the Rover program was terminated due to "changing national priorities and the lack of a US agency with a mission requiring a nuclear rocket engine" (Taub 1975:42). The great strides in reactor and engine design were truncated at the point of flight engine development. Additionally, the technology developed during the Rover program has direct applicability to the generation of electrical power in space (Koenig 1986:3). Overall, the program was a technological success, demonstrating that nuclear rocket engine was feasible (Taub 1975:42).

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V. PROJECT INFORMATION

This manuscript has been prepared at the request of the Department of Energy, Nevada Operations Office in response to the management of cultural resources on the Nevada Test Site. It is based on a previous investigation conducted by the Desert Research Institute, reported in Cultural Resources Reconnaissance Short Report No. SR021400-1, *An Historical Evaluation of the Test Cell A Facility in Area 25 for Characterization Activities Associated with Decontamination and Decommissioning, Nevada Test Site, Nye County, Nevada*, 2000. Additional background documents can be found at the DOE/NV Coordination and

Information Center in Las Vegas, Nevada and the Technical Information Center at the International Technologies Corporation in Las Vegas. Historic AEC and DOE/NV photographs and negatives are currently being stored at the Remote Sensing Laboratory (RSL) operated by Bechtel Nevada in Las Vegas. Engineer and architecture drawings on microfiche are currently stored at the Engineering Records Library in Mercury, Nevada on the NTS. Project Manager and Co-Principal Investigator for documentation of the facility was Colleen M. Beck, cultural resources specialist, of the Desert Research Institute, Las Vegas, Nevada; Harold Drollinger, professional archaeologist, of the Desert Research Institute, Las Vegas, was the second Principal Investigator; Nancy Goldenberg of Carey & Company, Inc. Architects, San Francisco, California was the historic architect; and the professional photographer was Richard Smith of Bechtel Nevada, Las Vegas.

Table 1. Test Cell A Nuclear Reactor Test Runs and Events.

TITLE	DATE	PURPOSE
Kiwi A	11/18/58	Testing main coolant pressure regulating system
Kiwi A	01/15/59	Frequency response test of main gas coolant
Kiwi A	01/24/59	Test of automatic mode
Kiwi A	02/28/59	Check on R-MAD disassembly bay
Kiwi A	02/28/59	Initial critical operation of reactor
Kiwi A	03/13/59	Load dump qualification test
Kiwi A	03/19/59	Test of H_2O and D_2O system through mockup reactor
Kiwi A	03/25/59	Test of H_2O and D_2O system through mockup reactor
Kiwi A	04/02/59	H_2 flow test, dry run
Kiwi A	04/03/59	H_2 flow test, hot run; hydrogen fire damaged mockup
Kiwi A	04/10/59	Simulated reactor operation
Kiwi A	04/11/59	Using Kiwi A control rods
Kiwi A	04/28/59	Gas and water flow, dry run, mockup used
Kiwi A	04/30/59	Gas and water flow, hot - helium used
Kiwi A	05/02/59	Gas and water flow, hot - hydrogen used
Kiwi A	06/03/59	Subsystem integral test, dry run
Kiwi A	06/04/59	Subsystem integral test, water flow
Kiwi A	06/05/59	Subsystem integral test, hot - helium and water flow
Kiwi A	06/06/59	Subsystem integral test, hot - noncritical
Kiwi A	06/13/59	Dry Test #1 - no gas or D_2O flow
Kiwi A	06/15/59	Dry Test #2 - cancelled
Kiwi A	06/16/59	Dry Test #3 - no gas and noncritical
Kiwi A	06/17/59	Power calibration - critical
Kiwi A	06/19/59	Reactor transfer function measurements
Kiwi A	06/20/59	Scaled-down full power run
Kiwi A	06/30/59	Dry full power run
Kiwi A	07/01/59	Hot full power run
Kiwi A Prime	06/24/60	Facility checkout
Kiwi A Prime	06/25/60	Gas flow
Kiwi A Prime	06/28/60	Neutronic calibration
Kiwi A Prime	06/29/60	Cancelled
Kiwi A Prime	06/30/60	Final system checkout
Kiwi A Prime	07/06/60	Low power run
Kiwi A Prime	07/08/60	Full power run
Kiwi A 3	09/15/60	Gas flow system checkout

Continued

Table 1. Continued.

TITLE	DATE	PURPOSE
Kiwi A 3	09/22/60	Nitrogen flow
Kiwi A 3	09/23/60	Nitrogen flow
Kiwi A 3	10/08/60	Neutronic calibration
Kiwi A 3	10/13/60	Low power run
Kiwi A 3	10/17/60	Cancelled
Kiwi A 3	10/19/60	Full power run
Kiwi B 1A	09/14/61	Flow system checkout
Kiwi B 1A	09/15/61	Flow system checkout
Kiwi B 1A	10/18/61	Flow system checkout
Kiwi B 1A	10/26/61	Simulation of full power run
Kiwi B 1A	10/31/61	Neutronic calibration test
Kiwi B 1A	11/02/61	Nozzle flow test
Kiwi B 1A	11/07/61	Cancelled
Kiwi B 1A	12/01/61	Neutronic calibration and scaled-down full power run
Kiwi B 1A	12/06/61	Cancelled
Kiwi B 1A	12/07/61	Full power run
Kiwi B CF	03/02/62	PCV-50 test
Kiwi B CF	04/13/62	Dewar pressurization test
Kiwi B CF	05/08/62	NFS-1 acceptance test (part 1)
Kiwi B CF	05/08/62	NFS-1 acceptance test (part 2)
Kiwi B CF	05/11/62	NFS-1 acceptance test (part 1)
Kiwi B CF	06/08/62	NFS-1 turbine duration test
Kiwi B CF	06/16/62	NFS-1 duration test
Kiwi B CF	06/29/62	First cold flow run
Kiwi B CF	07/07/62	First cold flow run
Kiwi B CF	07/14/62	Second cold flow run
Kiwi B 1B	08/09/62	Simulated full power run
Kiwi B 1B	08/25/62	Reactor calibration
Kiwi B 1B	08/29/62	Low power run profile
Kiwi B 1B	09/01/62	Full power run
Kiwi B 4A	09/19/62	NFS-1 duration test
Kiwi B 4A	10/10/62	NFS-1 turbine test
Kiwi B 4A	10/31/62	LH_2 startup test
Kiwi B 4A	11/14/62	Power calibration
Kiwi B 4A	11/20/62	Scaled-down power run

Continued

Table 1. Continued.

TITLE	DATE	PURPOSE
Kiwi B 4A	11/28/62	Full power run
Kiwi B 4A CF	04/24/63	NFS-1 checkout
Kiwi B 4A CF	05/15/63	Gas flow section
Cold Flow	06/27/63	Mixing Chamber
Cold Flow	07/26/63	Mixing Chamber
Cold Flow	08/15/63	Mixing Chamber
Cold Flow	08/28/63	Mixing Chamber
Cold Flow	09/20/63	Mixing Chamber
Cold Flow	10/03/63	Mixing Chamber
NRX A4 EST	12/08/65	Initial criticality and control drum measurements
NRX A4 EST	12/15/65	Pressure loop checkout and initial cold flow tests
NRX A4 EST	01/06/66	Initial cold flow bootstrap
NRX A4 EST	01/19/66	Cold flow tests
NRX A4 EST	01/21/66	Neutronics calibration, control drum worth measurements, and low power dosimetry
NRX A4 EST	02/02/66	Neutronics RAMS set, scaled-down power test, and intermediate power bootstrap tests
NRX A4 EST	02/03/66	Neutronics RAMS set, scaled-down power test, and intermediate power bootstrap tests
NRX A4 EST	02/11/66	Intermediate power bootstrap and controls test
NRX A4 EST	03/03/66	Full power and engine mapping test
NRX A4 EST	03/16/66	Engine duration test
NRX A4 EST	03/25/66	Engine duration test
NRX A5	05/26/66	Initial criticality and cold flow test
NRX A5	06/08/66	Neutronics calibration, dosimetry and scaled-down power run
NRX A5	06/08/66	First full power test
NRX A5	06/23/66	Second full power test

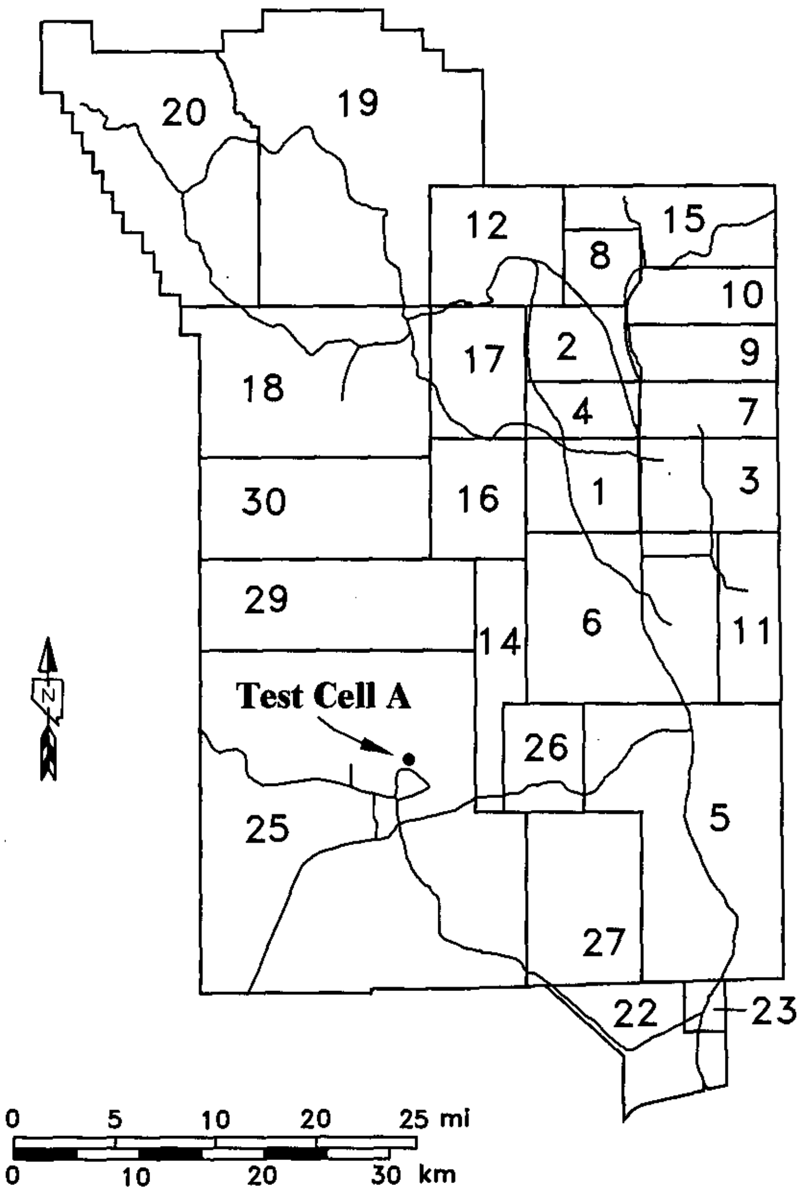

Figure 1. Location of the Test Cell A Facility on the Nevada Test Site.

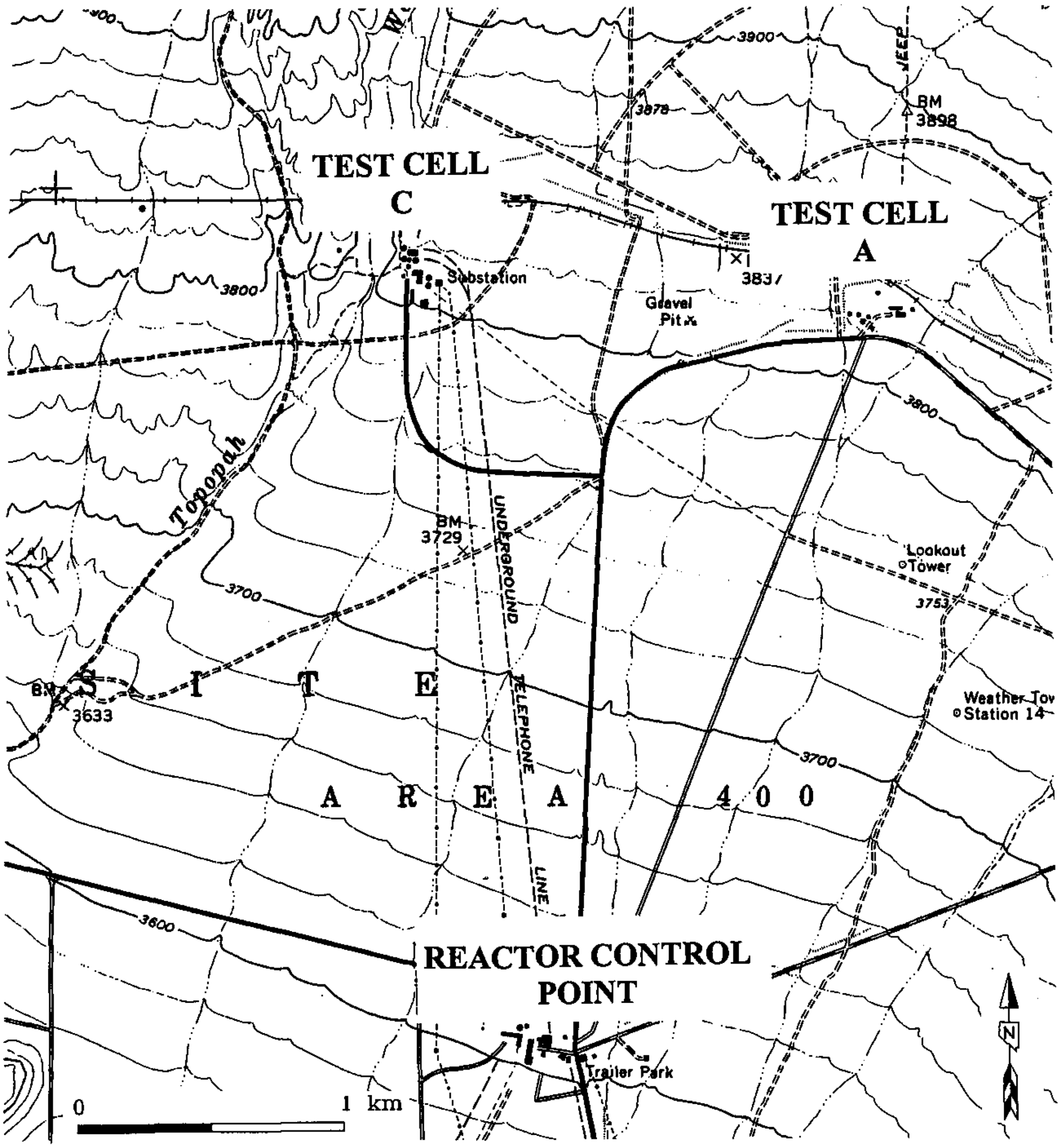

Figure 2. Test Cell A Facility and surrounding topographic features.

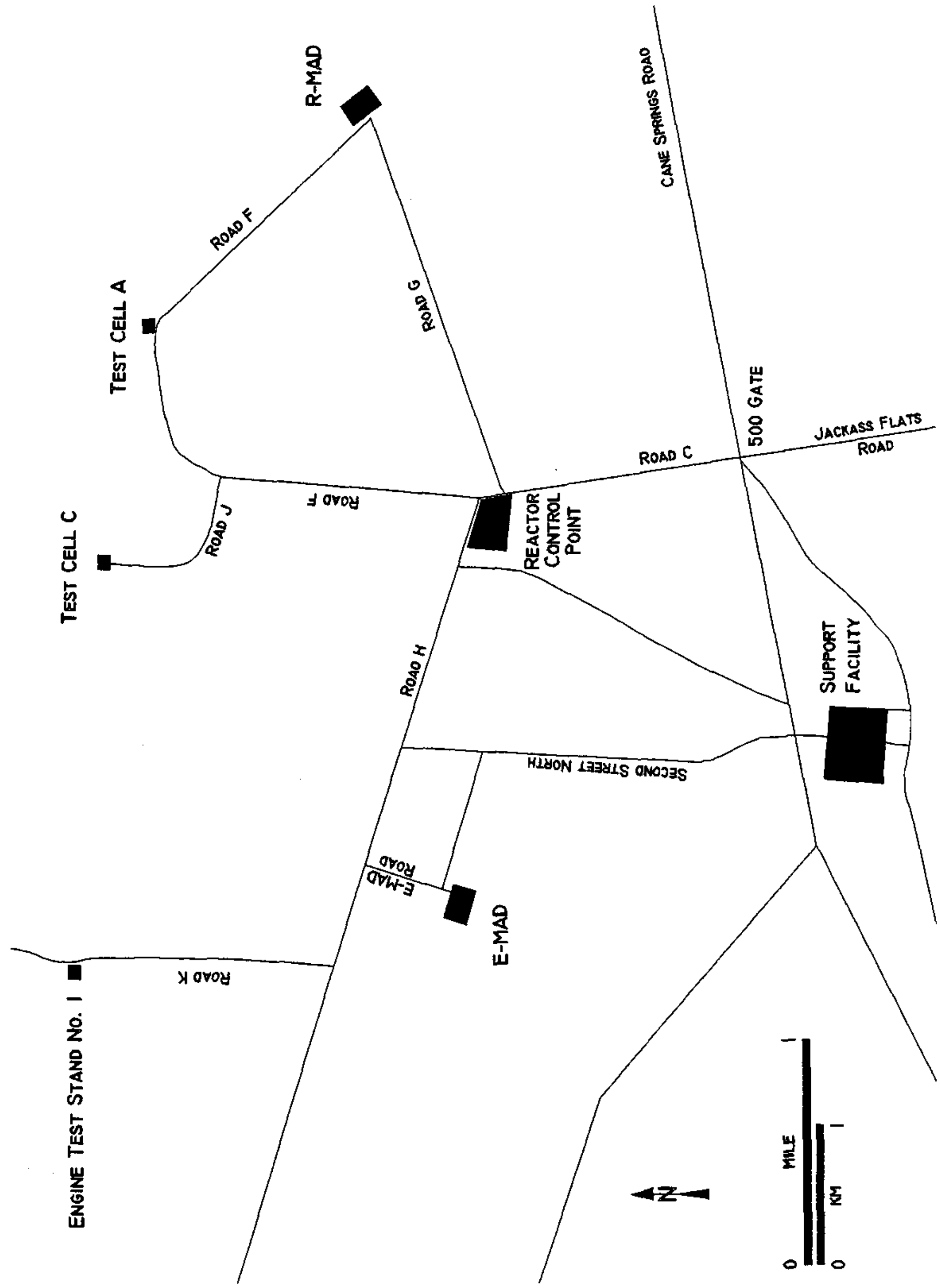

Figure 3. Major facilities of the Nuclear Rocket Development Station.

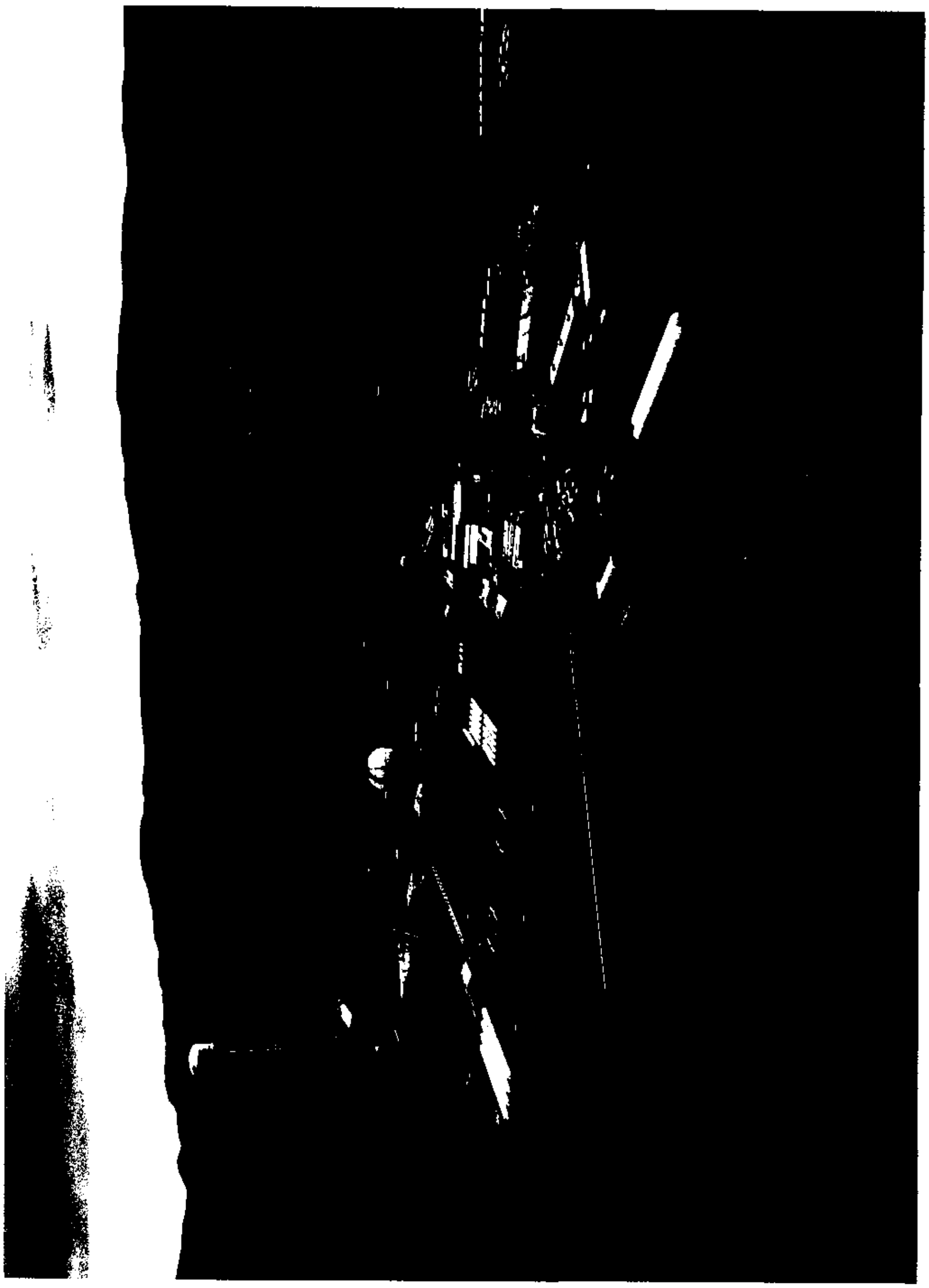

Figure 4. Test Cell A facility with view to southeast.

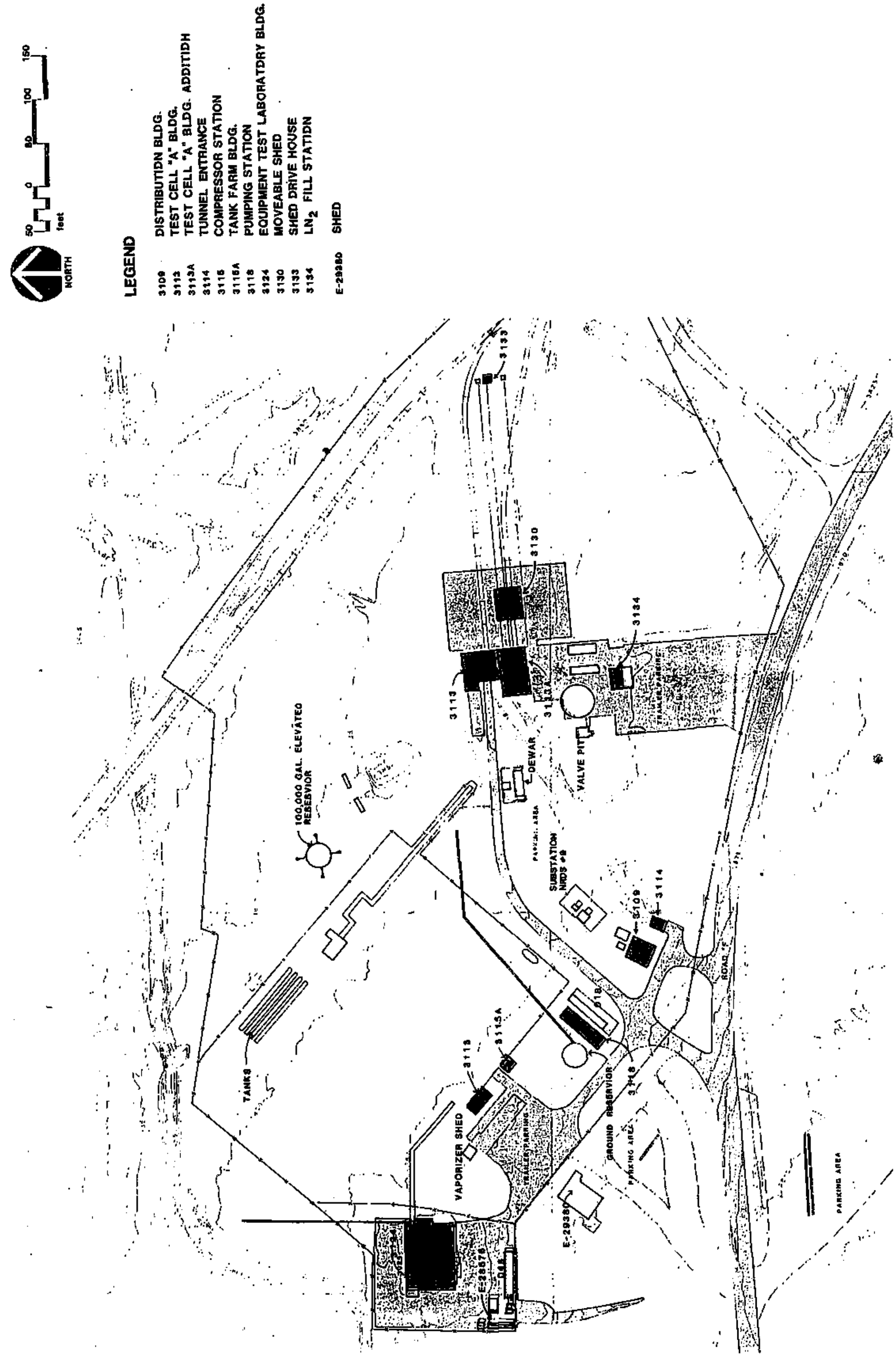

Figure 5. Plan map of the Test Cell C Facility, ca. 1994.

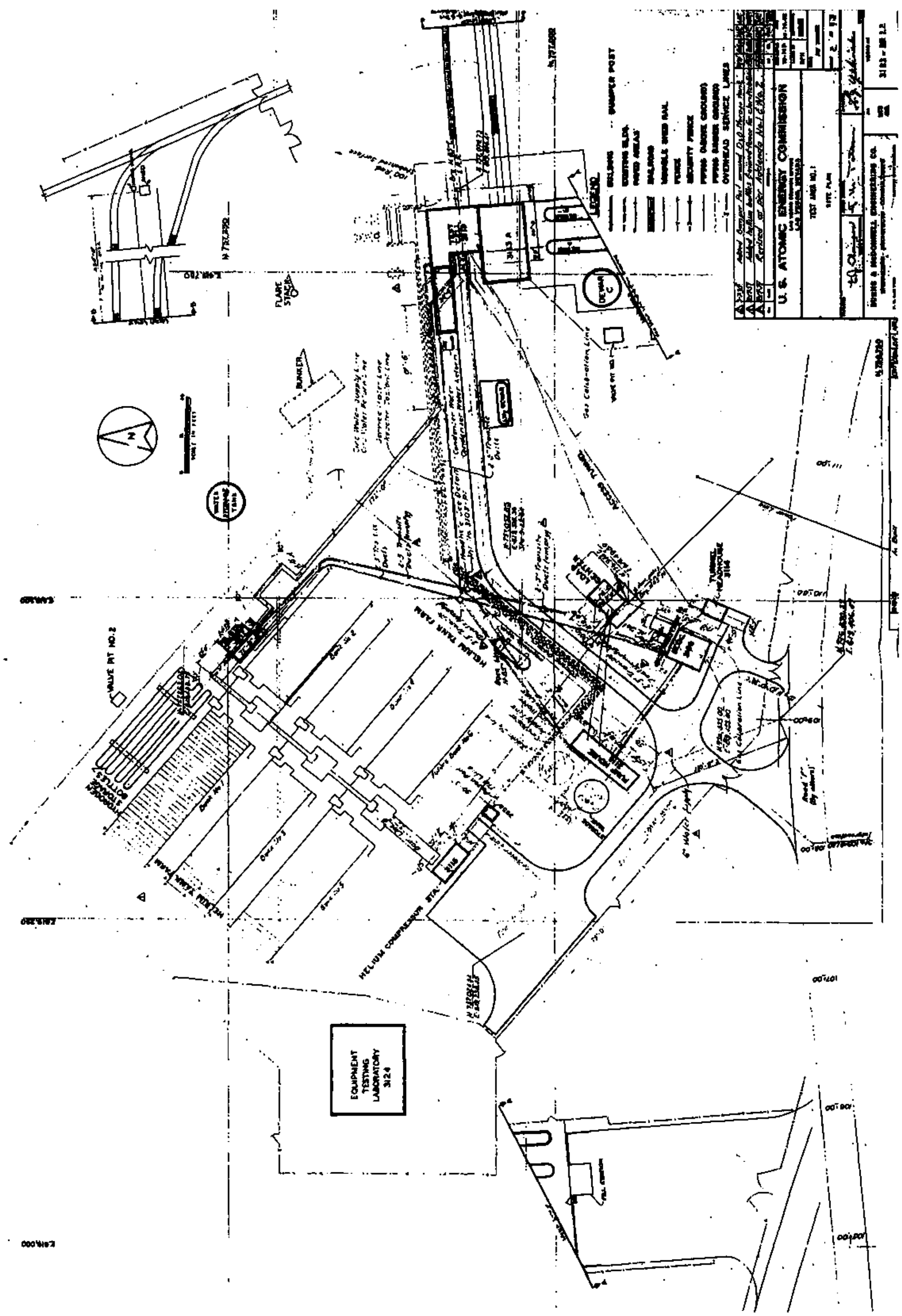

Figure 6. Test Cell A site plan, 1964.

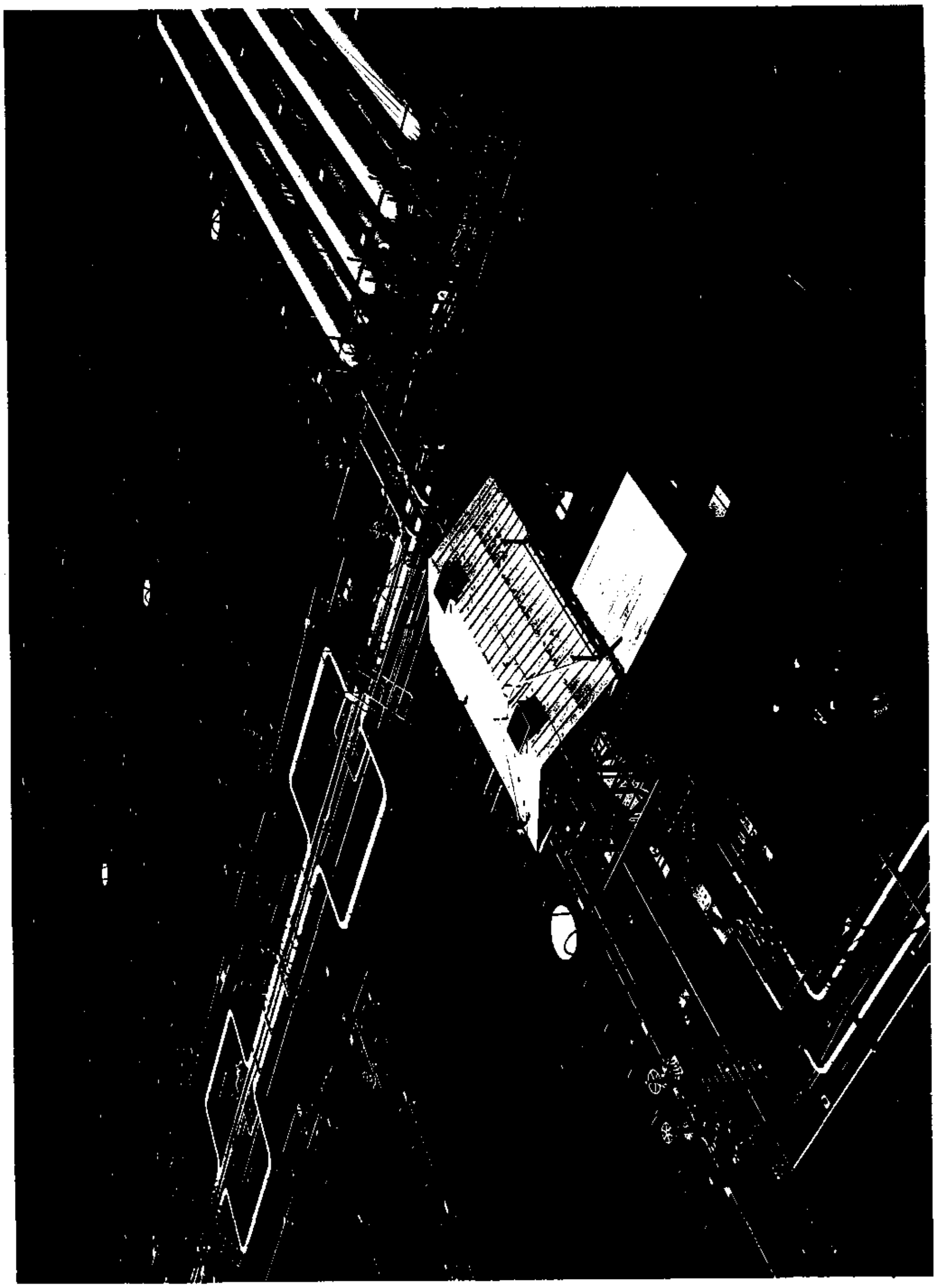

Figure 7. Tank farm at Test Cell A facility.

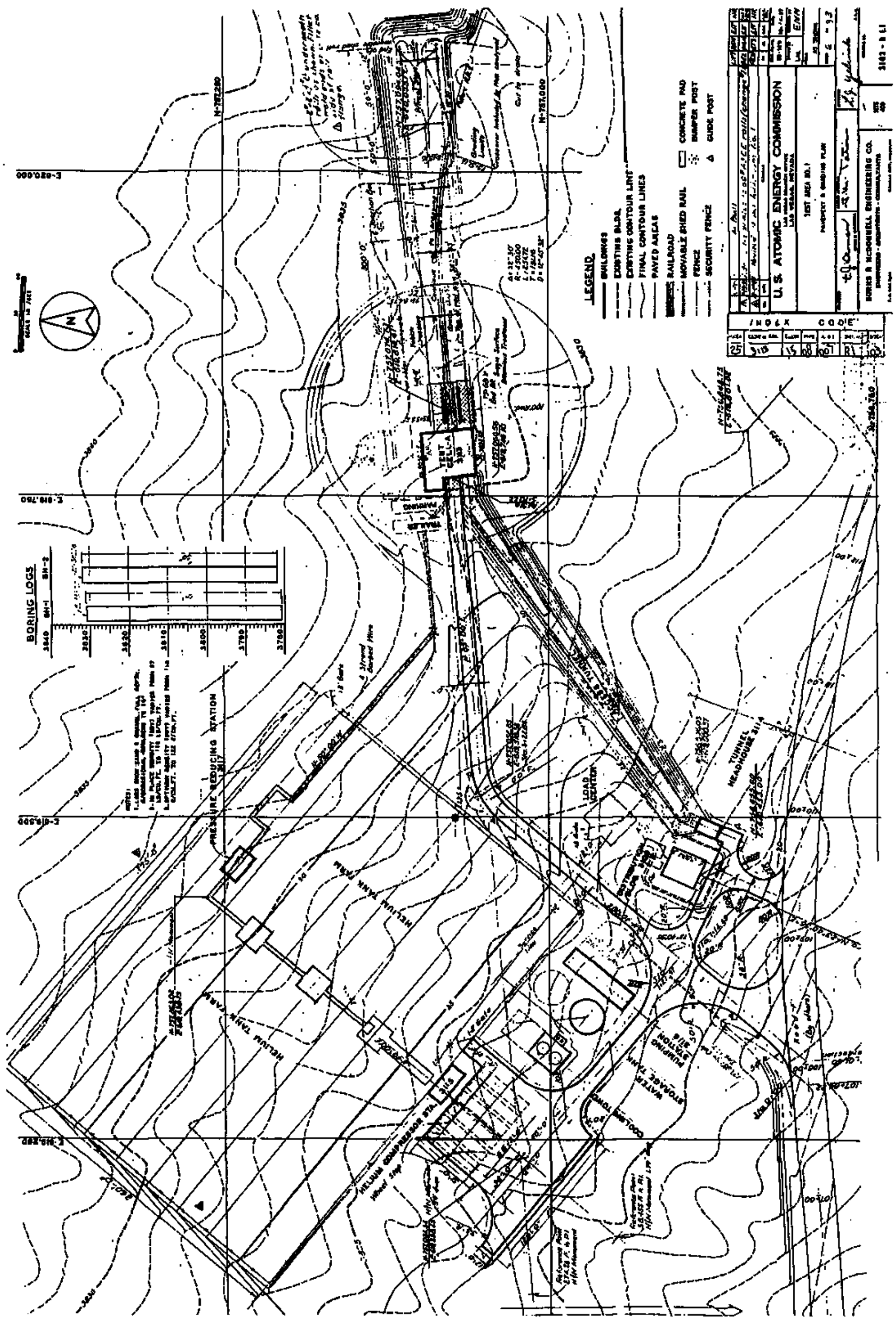

Figure 8. Test Cell A pavement and grading plan, 1957.

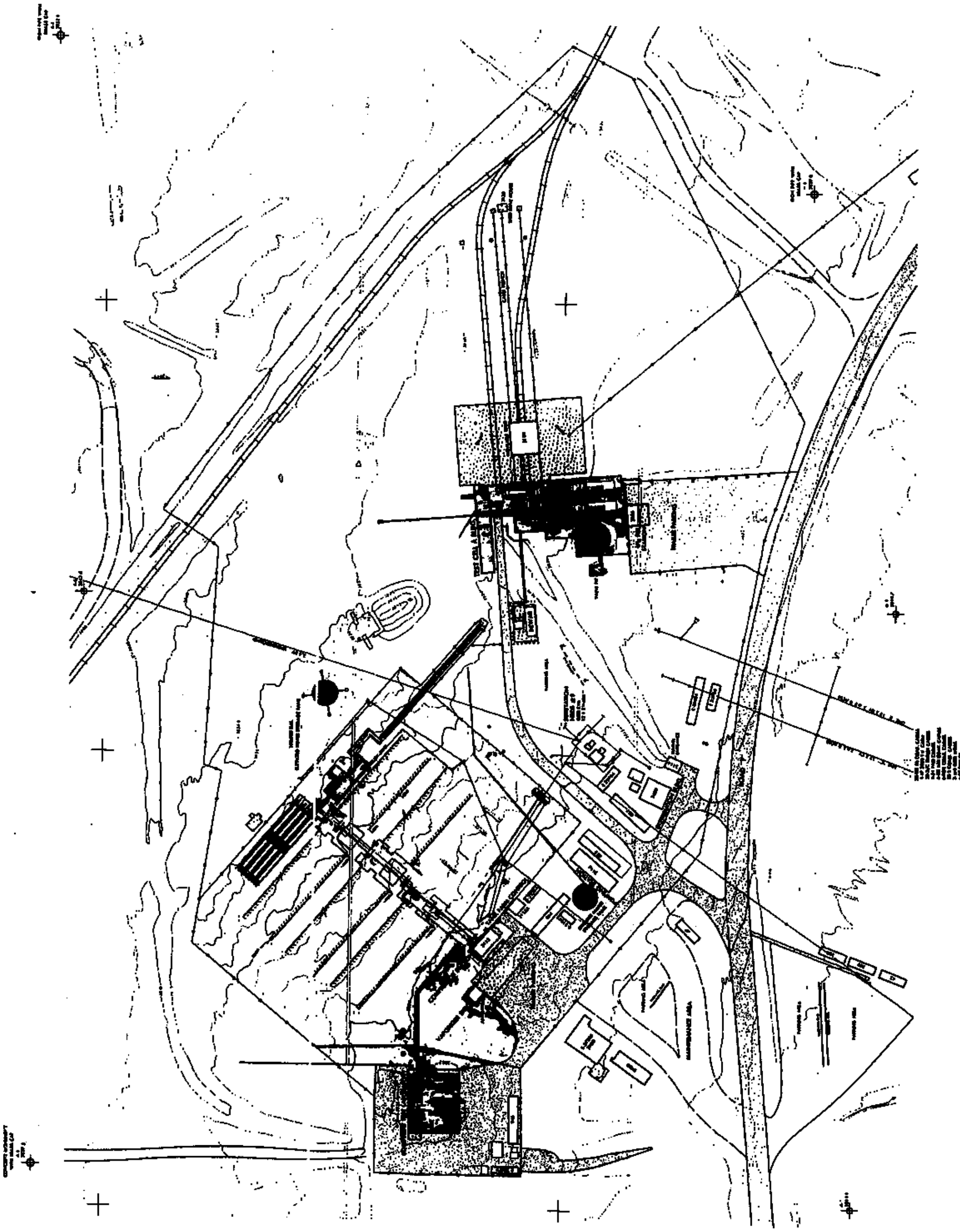

Figure 9. Detail site map Test Cell A complex, 1965.

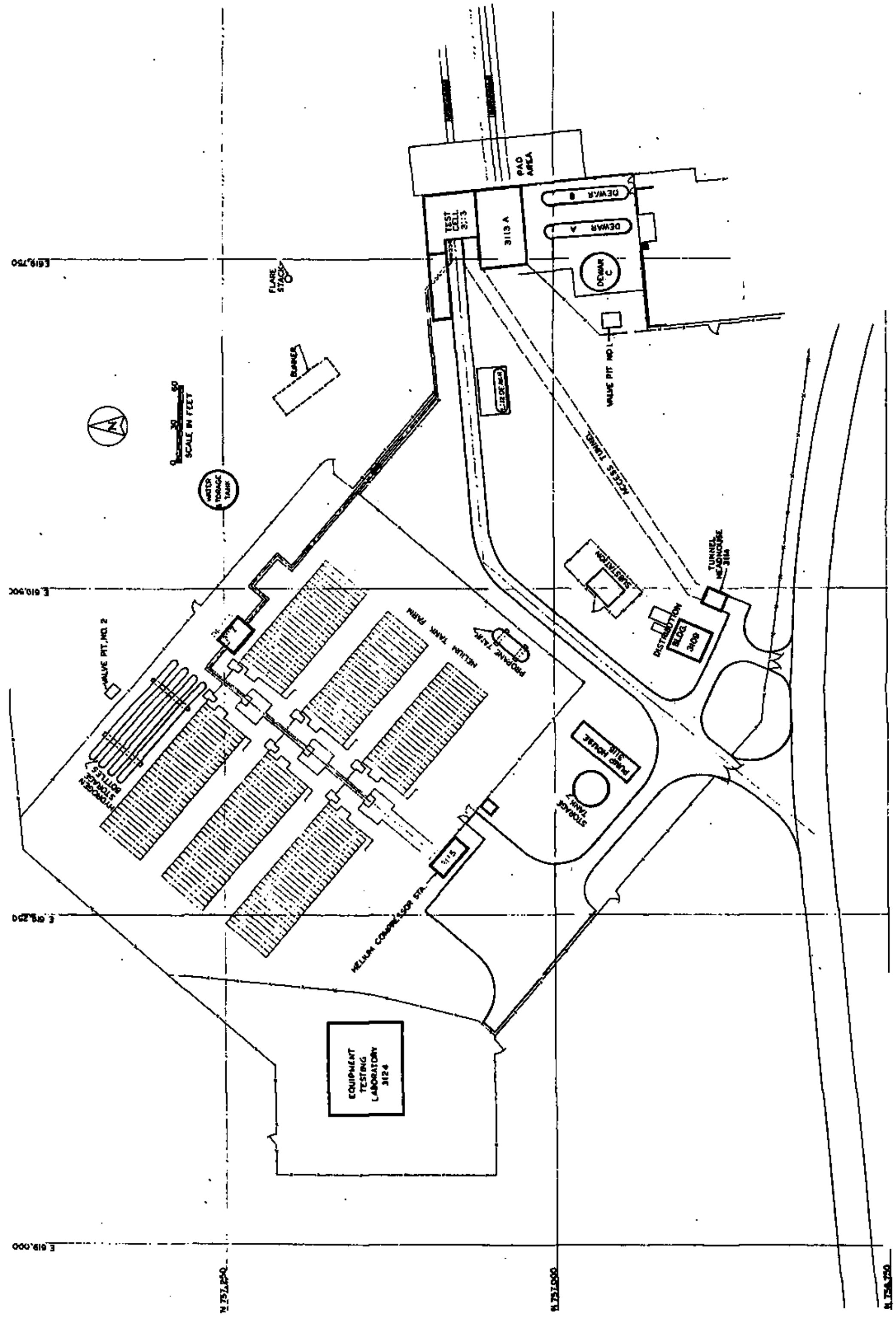

Figure 10. Test Cell A site plan, 1964.

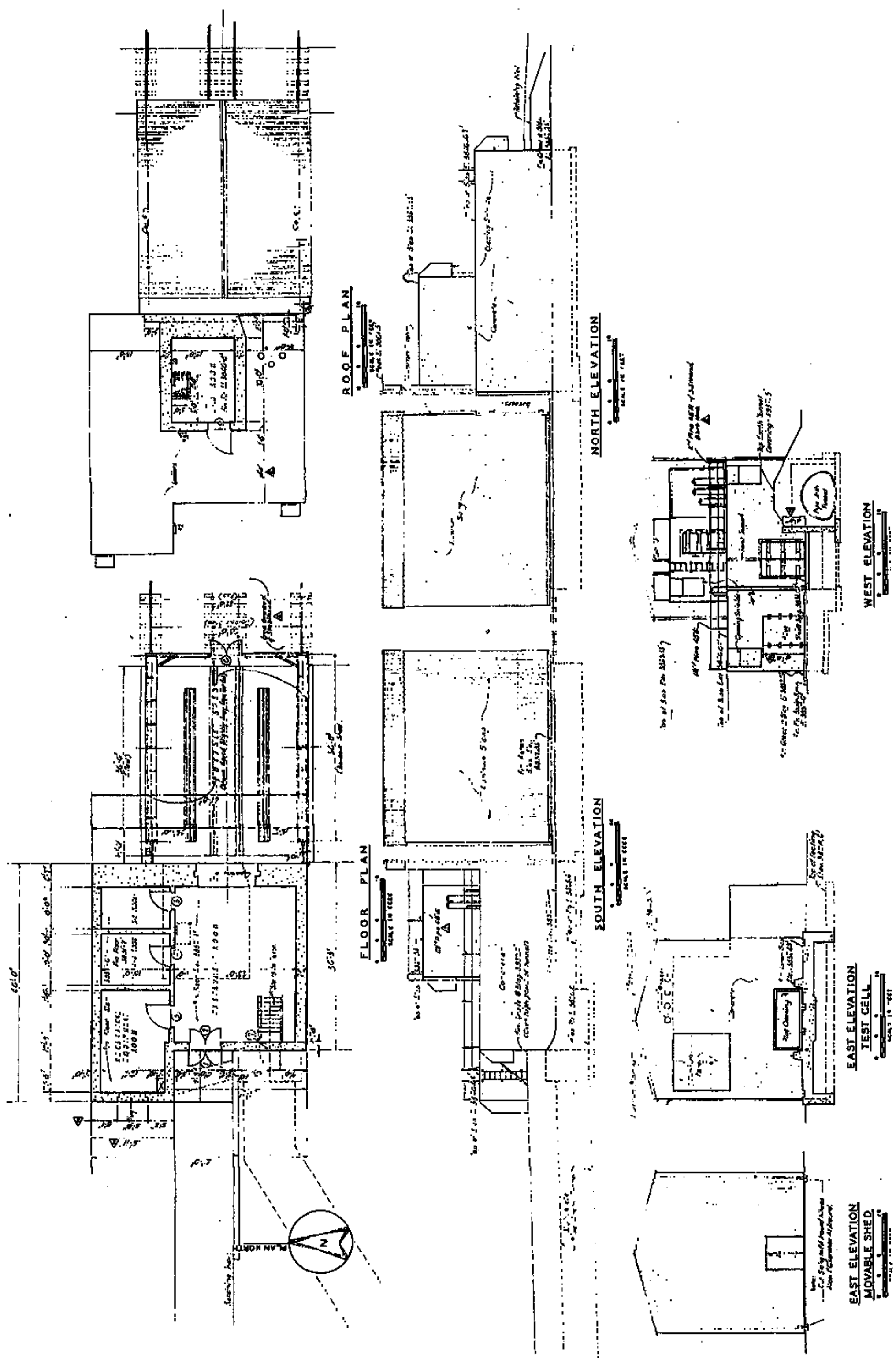

Figure 11. Building 3113, Test Cell A, plans and elevations.

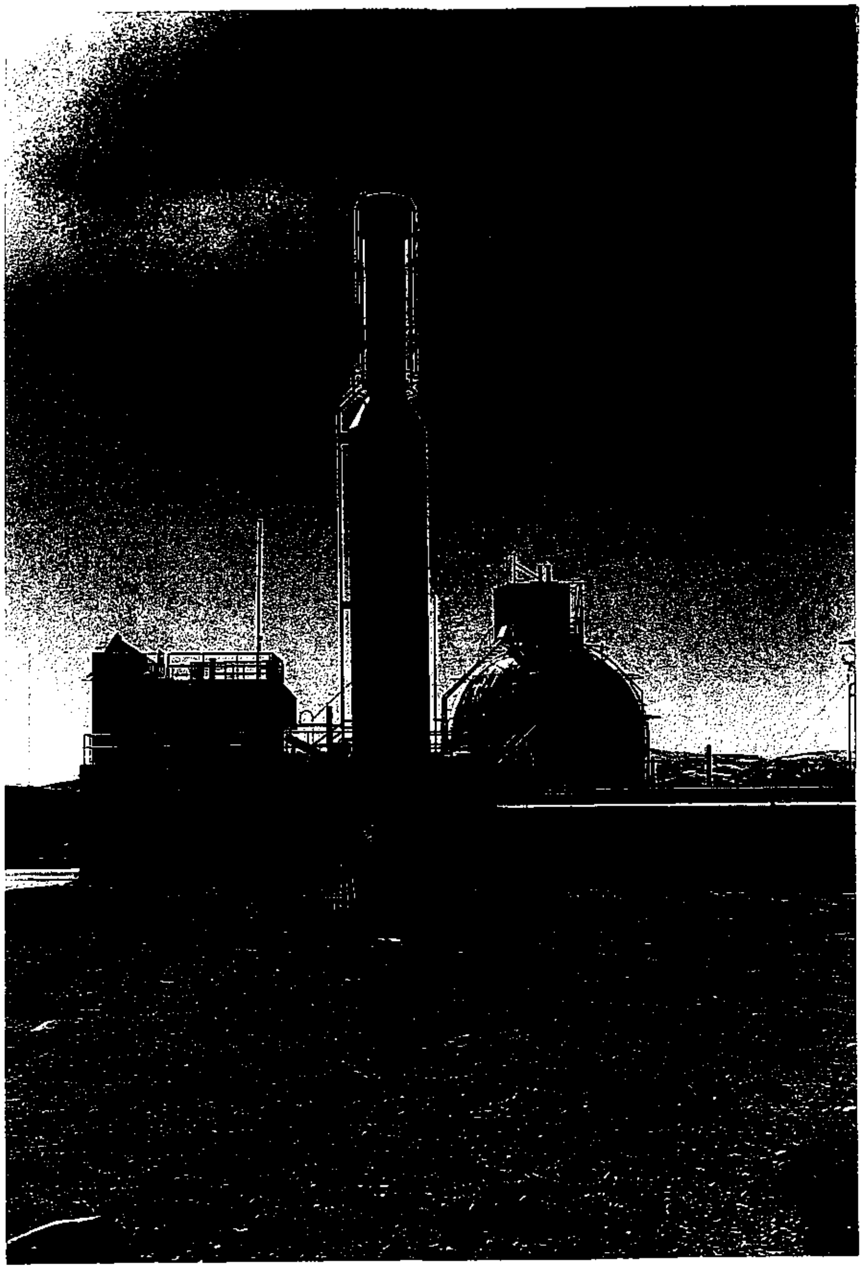

Figure 12. Flare at Test Cell A, view to south.

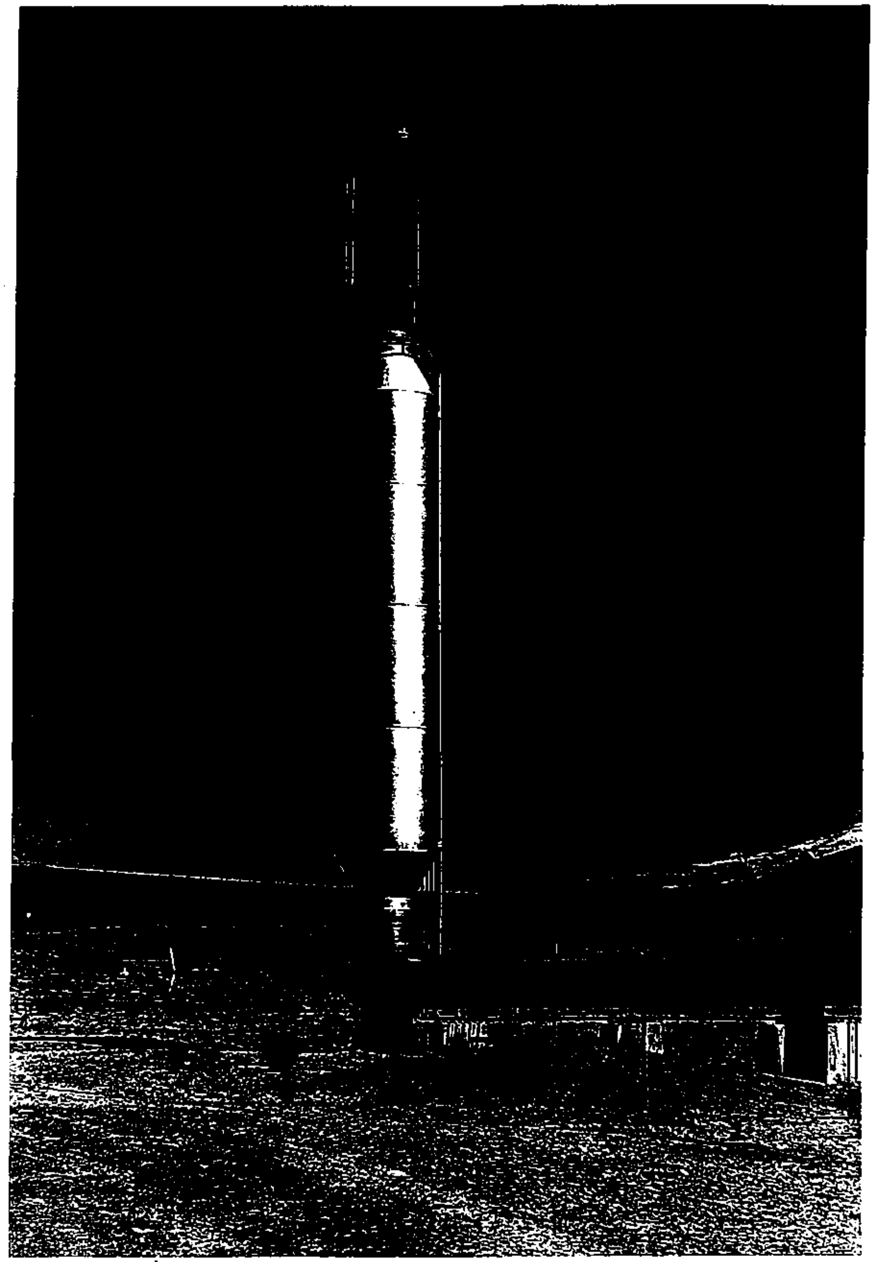

Figure 13. Flare at Test Cell A, view to northeast.

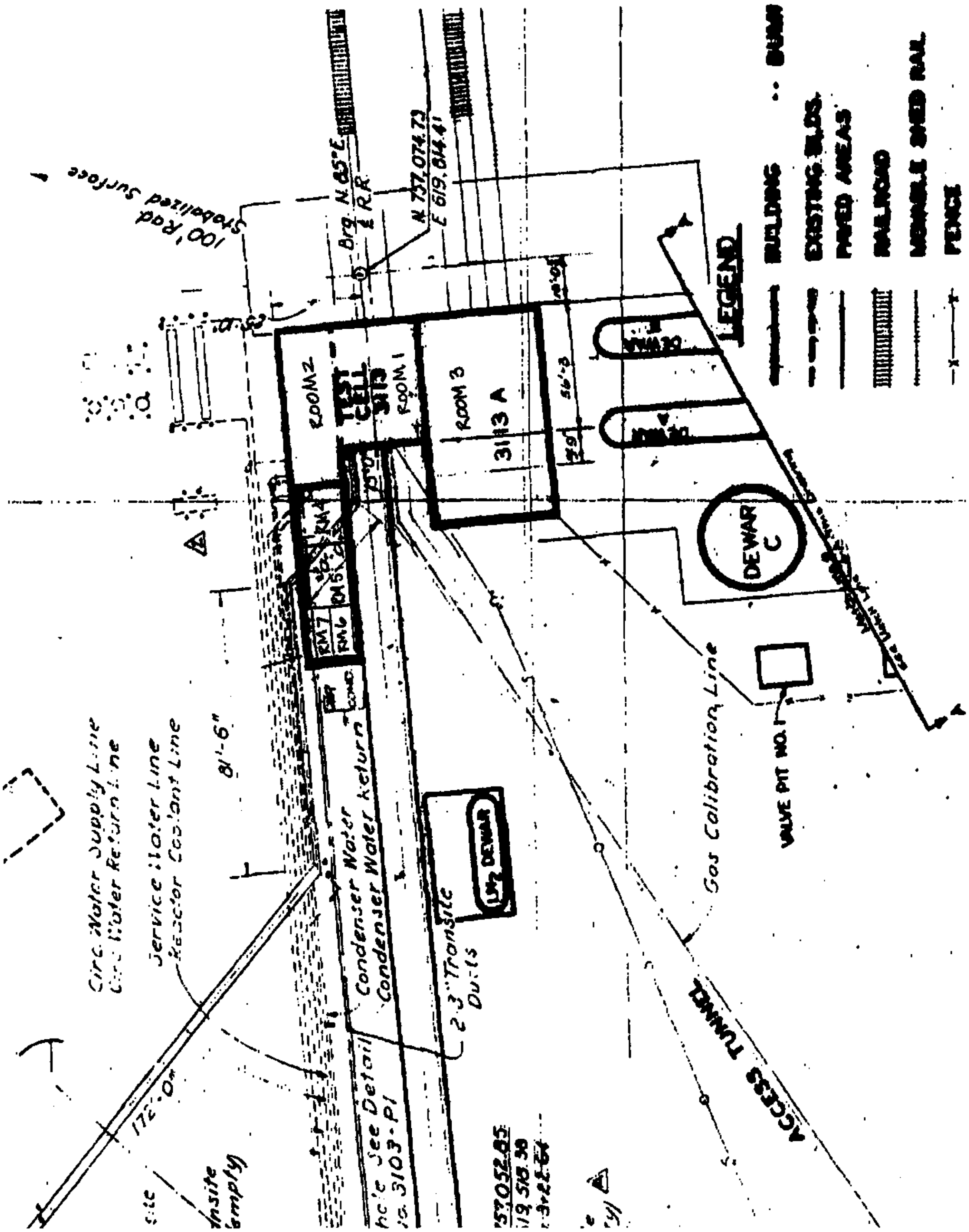

Figure 14. Detail of building 3113/3113A with room numbers.

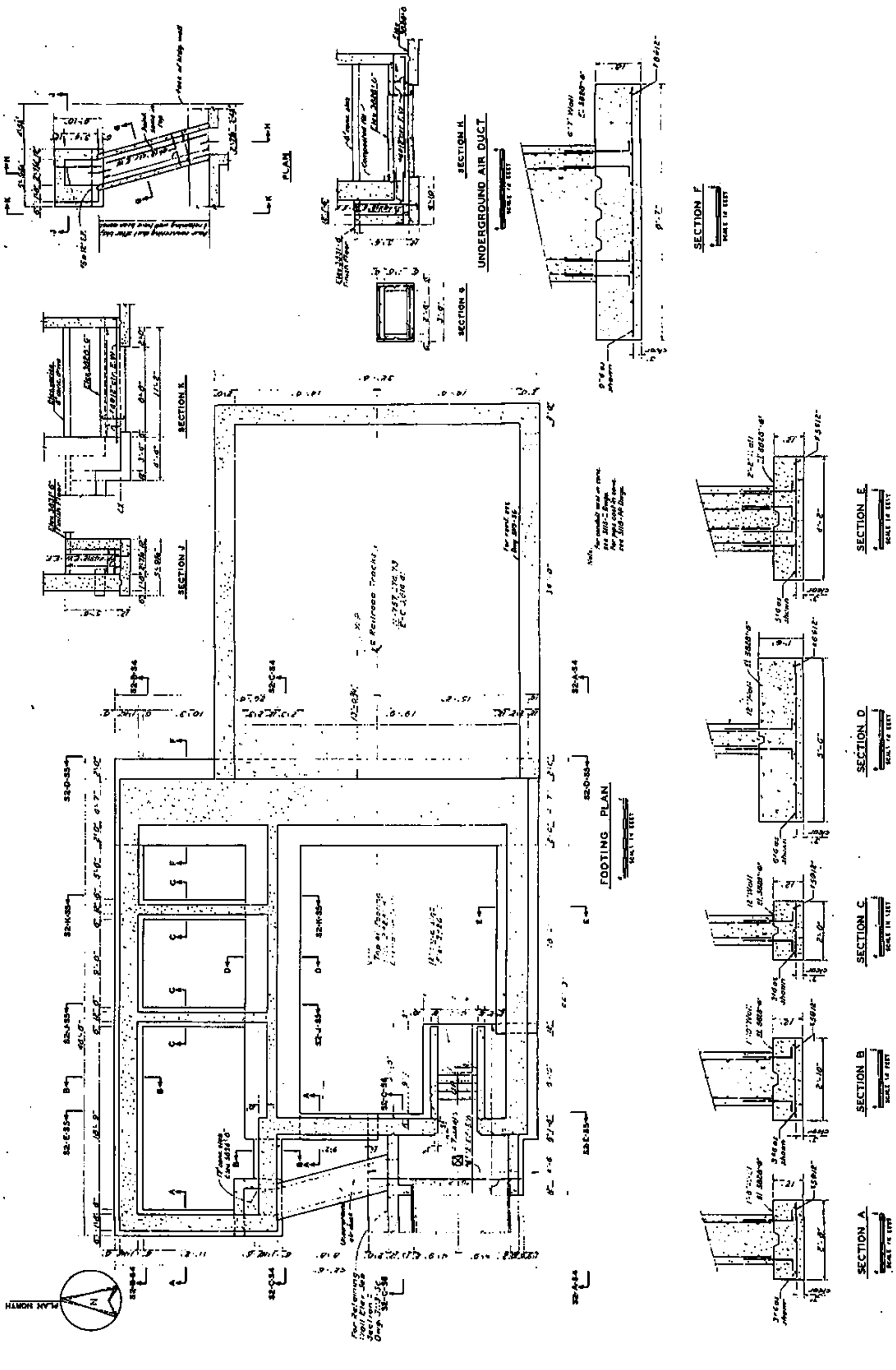

Figure 15. Footing plan of building 3113, 1957.

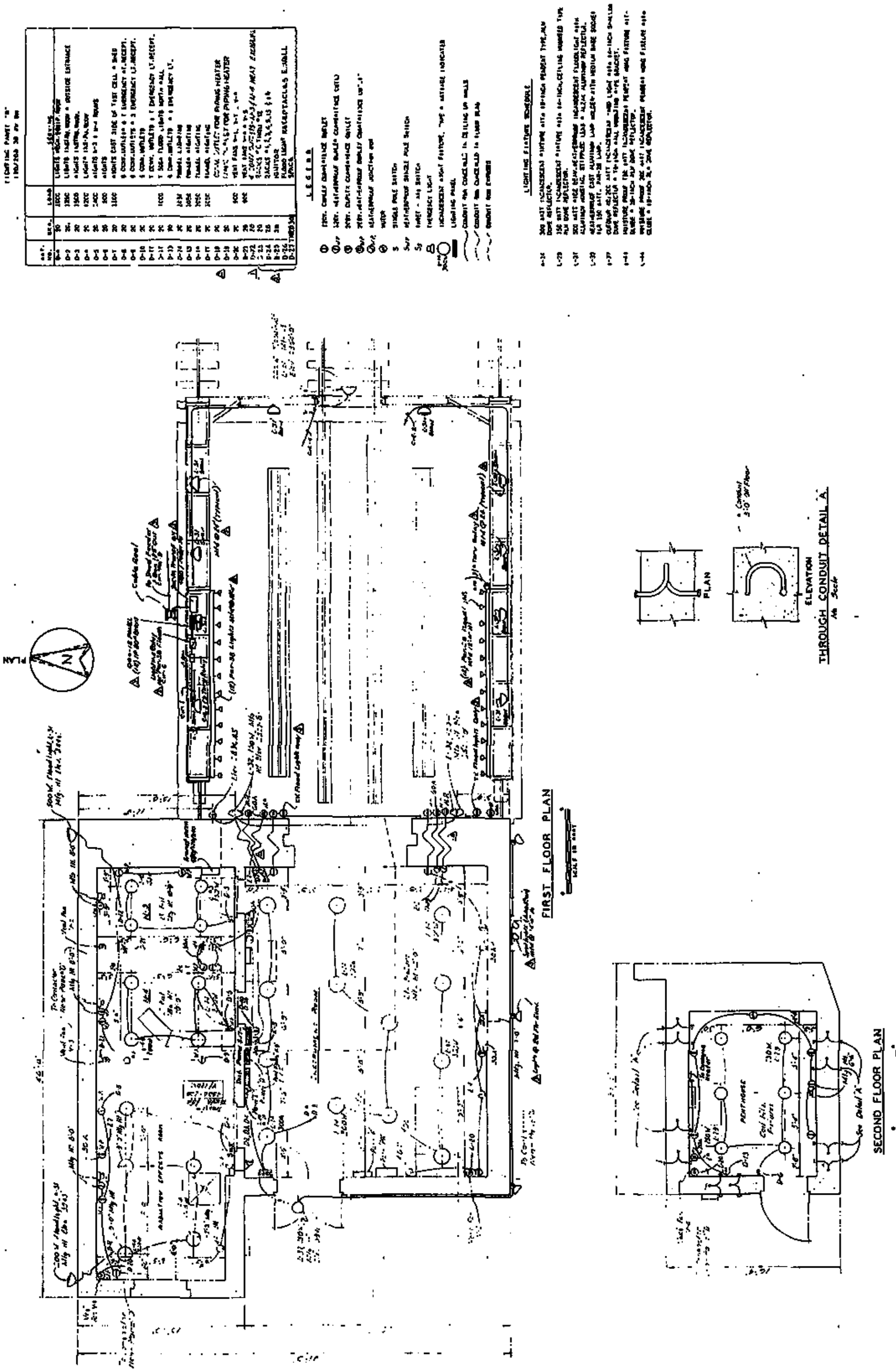

Figure 16. Lighting plan and details for building 3113 including penthouse, 1957.

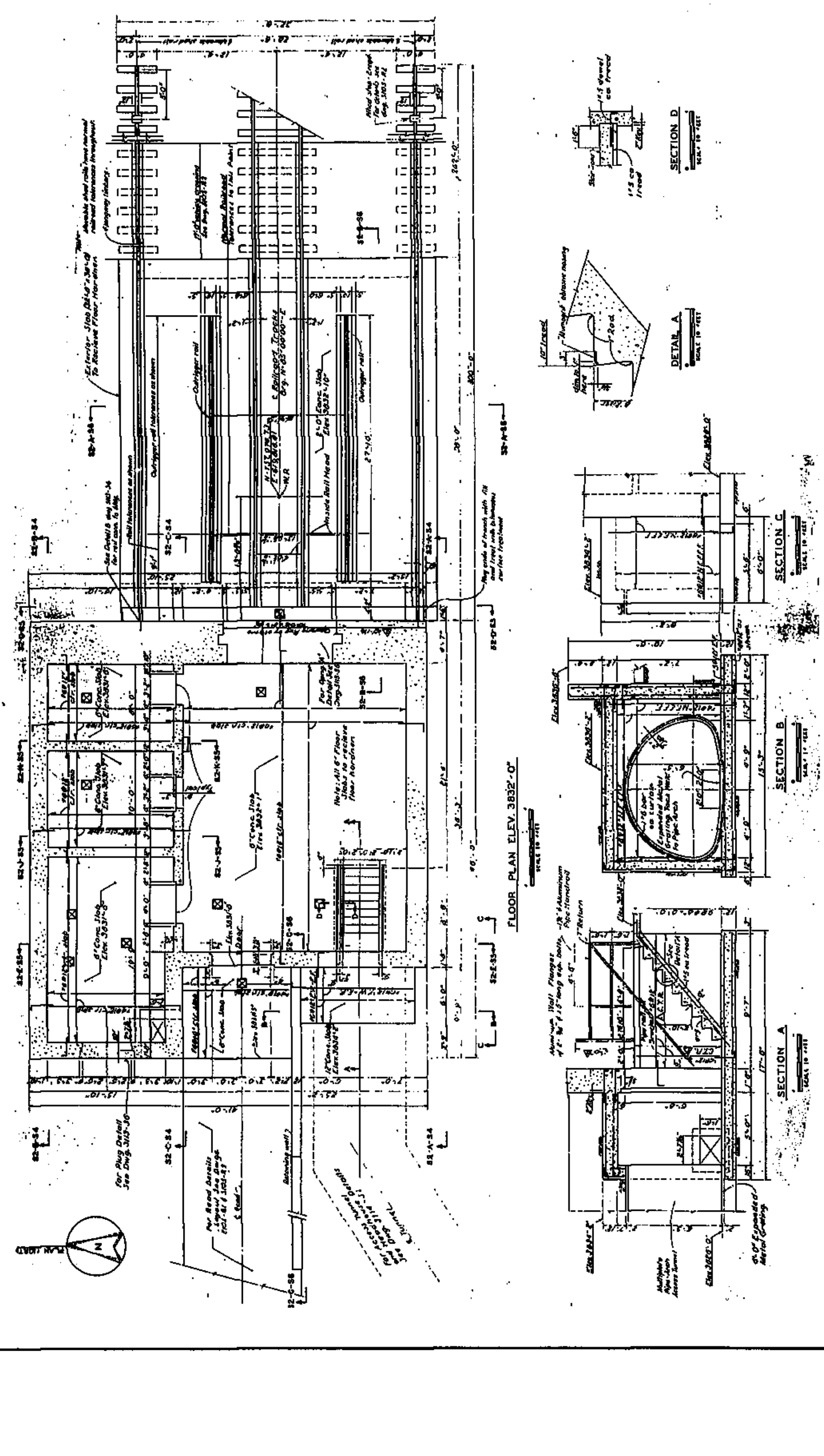

Figure 17. Floor plan and details, building 3113, 1957.

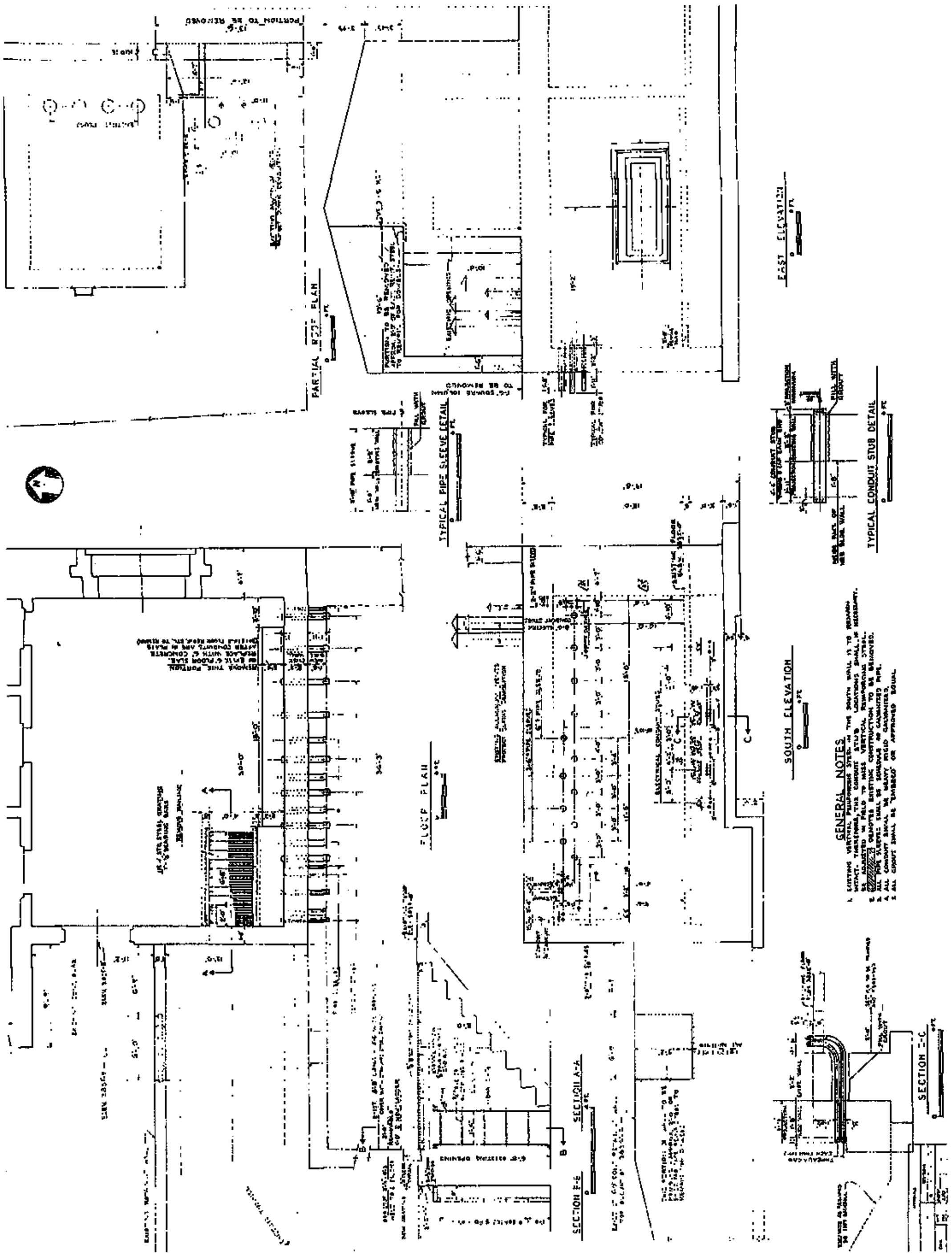

Figure 18. Building 3113 alterations, 1960.

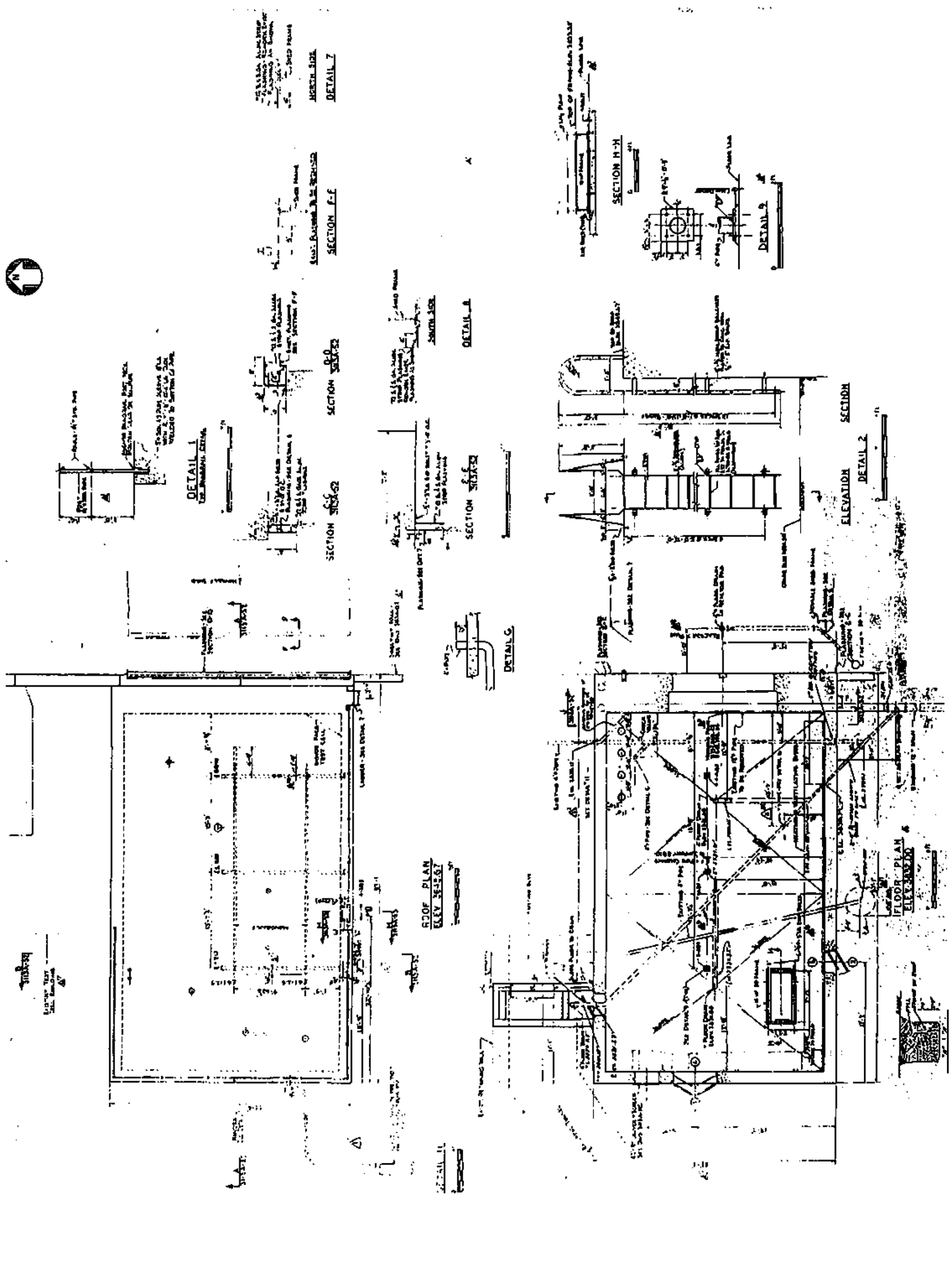

Figure 19. Building 3113 addition plans, 1960.

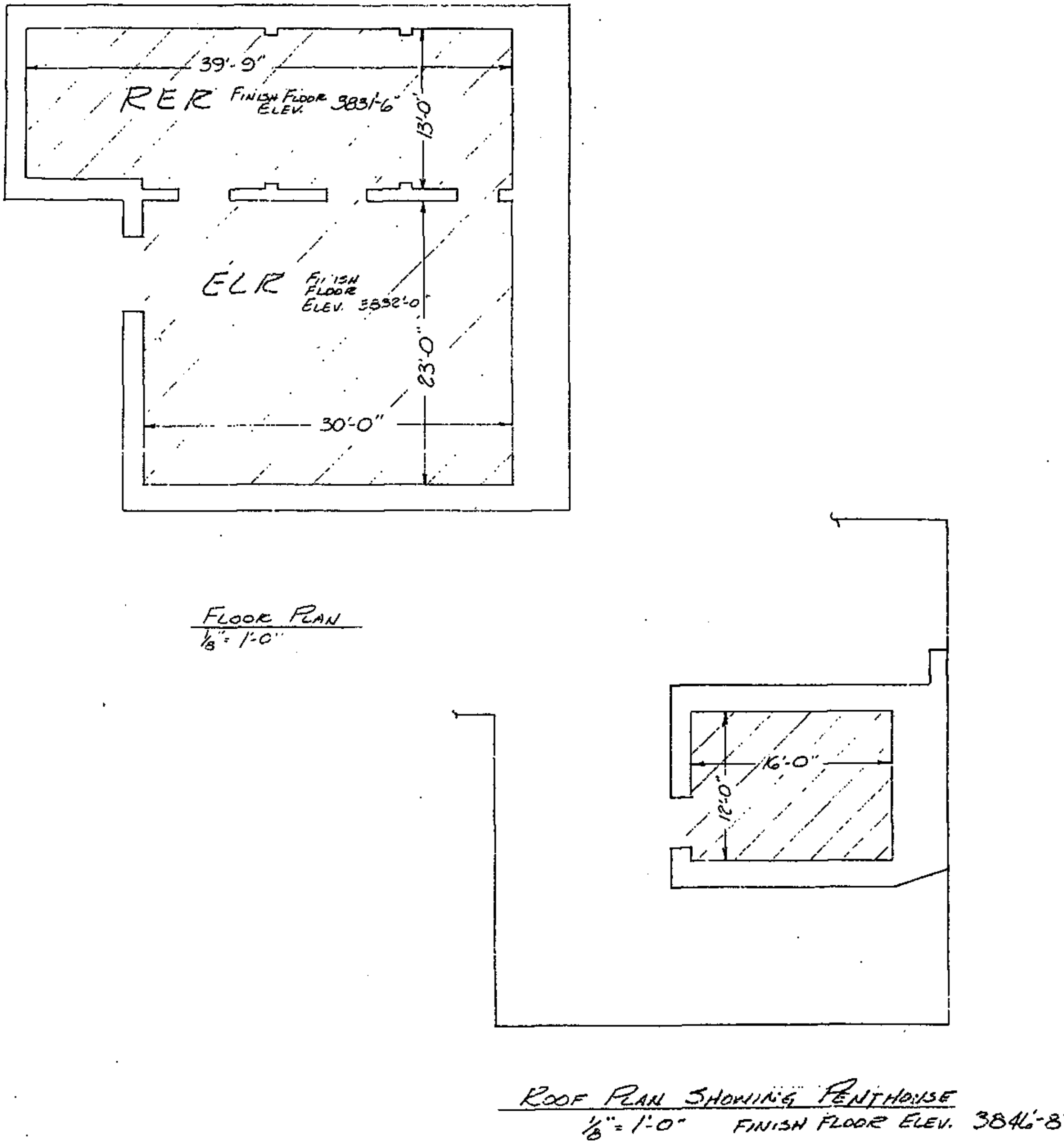

Figure 20. Building 3113 floor plan and roof plan showing penthouse, 1963.

Figure 21. Reactor assembly at R-MAD.

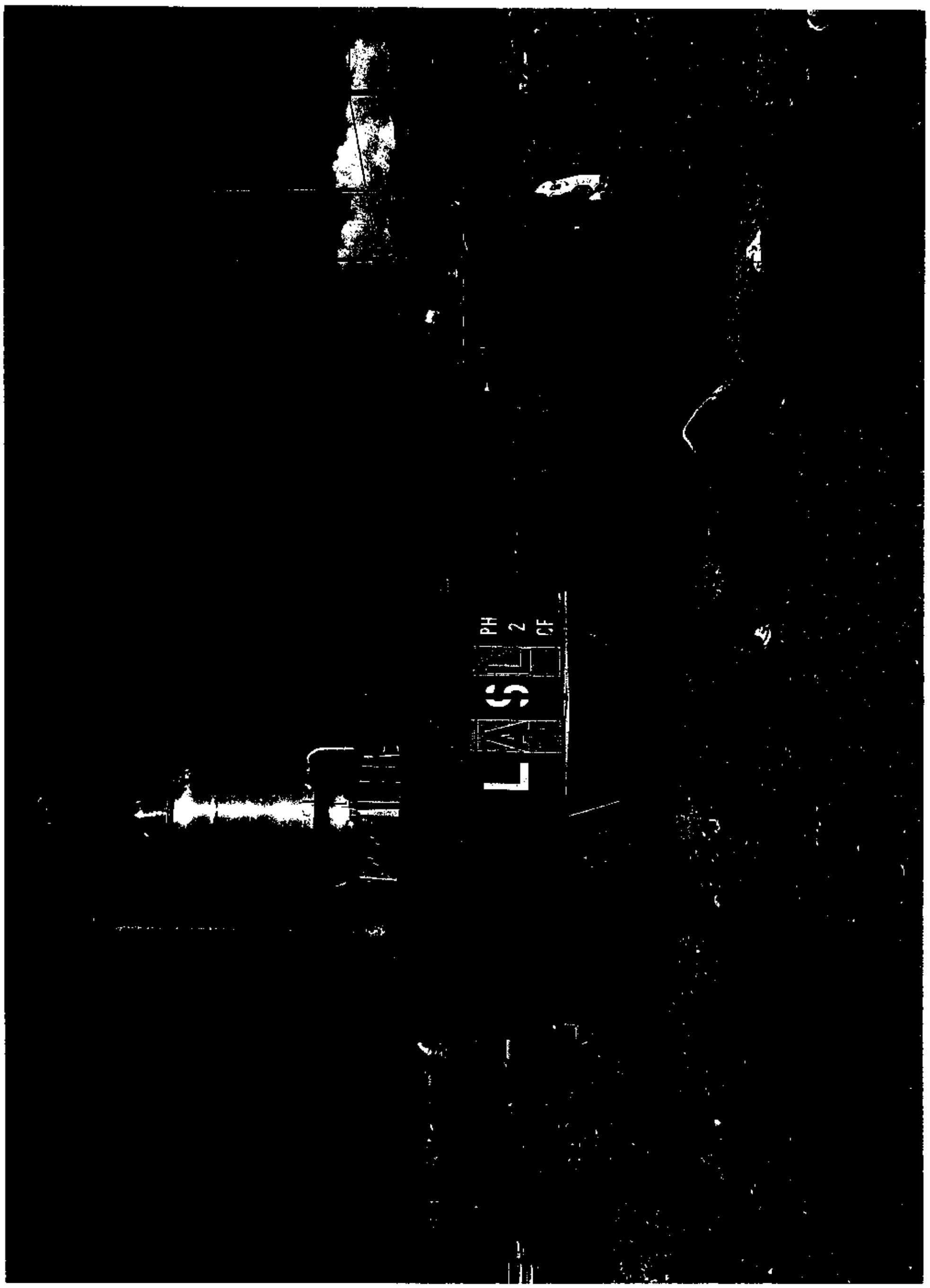

Figure 22. Transport of reactor to test cell by railroad.

Figure 23. Nuclear rocker reactor test at Test Cell A.